Instruction Manual

JOHN FLUKE MFG. CO., INC.

ELECTRONICS FOR INDUSTRY

MODEL 823A

AC/DC

DIFFERENTIAL VOLTMETER

INSTRUMENTS / COMPONENTS

JOHN FLUKE MFG. CO. INC.
P. O. Box 7428 Seattle 33, Washington

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MODEL 823A

AC/DC DIFFERENTIAL VOLTMETER

823A serial no. 175 and above.

823AR serial no. _____ and above.

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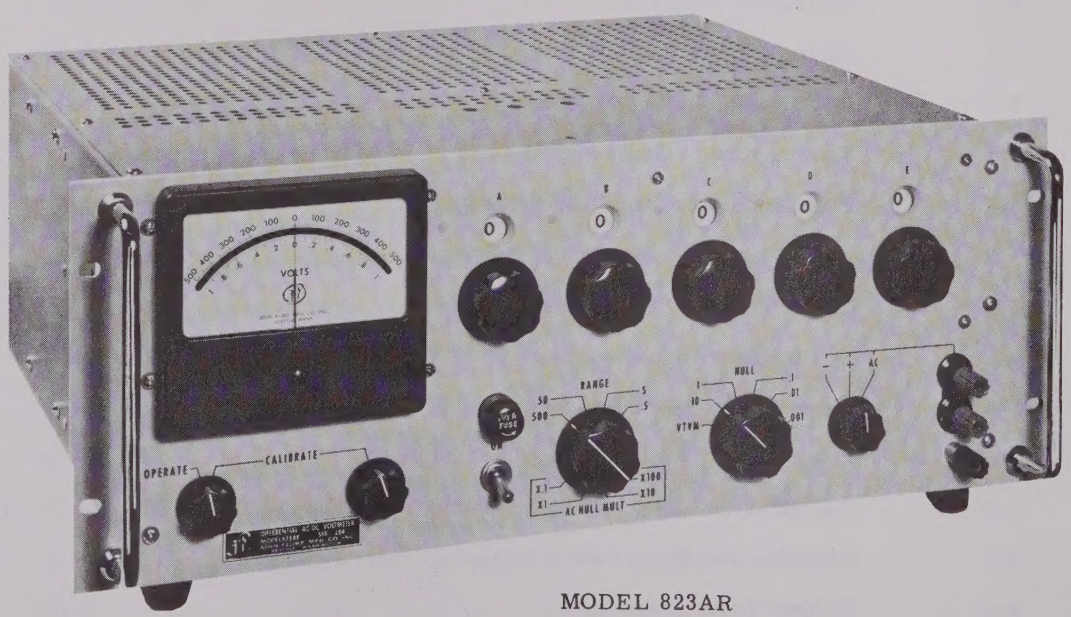


MODEL 823AR

SECTION I

INTRODUCTION AND SPECIFICATIONS

1-1. INTRODUCTION

a. This instruction manual is for use with the 823A series AC/DC Differential Voltmeters. The 823A is available in a cabinet model or a model designed to fit a standard 19 inch rack. Rack models are denoted by an "R" immediately following the 823A part of the model number.

b. The high accuracy, portability, and compactness of the 823A make this instrument ideal for the precise measurement of almost any AC or DC voltage. Ease of operation, inherent protection from accidental overload, and high reliability contribute to the outstanding performance that assures suitability for both production line testing and precision laboratory measurements. This instrument is capable of being used as a vacuum tube voltmeter, as a precision potentiometer, and as a megohmmeter for measurement of high resistance. It can also be used to measure the excursions of a voltage about some nominal value. One feature that should be emphasized is that no current is drawn from the unknown source for DC measurements when balance is attained. Thus the determination of the unknown DC potential is independent of its source resistance. The 823A is basically used for measurements of DC voltages from 0 to 500 volts and AC voltages from 0.001 to 500 volts. However, high accuracy measurements to 30,000 volts DC are possible with precision voltage dividers especially designed for use with the Fluke 800 series differential voltmeters. As additional features, this instrument contains a polarity switch for equal convenience in measuring positive or negative DC voltages and an adjustable recorder output which makes the 823A particularly useful for monitoring the stability of almost any AC or DC voltage. Furthermore, the 823A meter has taut-band suspension which eliminates problems due to meter stickiness.

c. When used as a DC differential voltmeter, the 823A operates on the potentiometric principle. An unknown voltage is measured by comparing it to a known adjustable reference voltage with the aid of a null detector. An accurate standard for measurements is obtained by setting the reference supply with a standard cell. The known adjustable reference voltage is provided by a 500 volt DC power supply and five Kelvin-Varley decade resistor strings that are set by five voltage readout dials. In this way, the 500 volts can be precisely divided into increments as small as 10 microvolts. The unknown voltage is then simply read from the voltage dials. When used as an AC differential voltmeter, the 823A operates essentially the same as for DC differential measurements. The AC input voltage is converted to a DC voltage and this DC voltage is measured by comparing it to a known adjustable reference voltage. In the highest recommended null sensitivity range, potential differences between the unknown and the reference voltage of only 0.001 volts for DC and 0.001 volts for AC will cause full scale meter deflection.

d. The instrument is normally supplied ready for use on 115 volts. Upon request, instruments are supplied for 230 volt operation. If it becomes desirable to convert from one mode of operation to the other, refer to the instruction decal on the back of cabinet models or on the cover in rack models.

1-2. DAMAGE IN SHIPMENT

Immediately upon receipt, thoroughly inspect for any damage that may have occurred in transit. If any damage is noted, follow the instructions outlined on the warranty page at the back of this manual.

1-3. SPECIFICATIONS

AS A PRECISION POTENTIOMETER

DC ACCURACY:

±0.01% of input voltage from 0.5 to 500 VDC
±(0.01% + 10 uv) below 0.5 VDC

AC ACCURACY:

Input Voltage	Basic AC Accuracy		Low Frequency AC Accuracy		High Frequency AC Accuracy	
	30 cps to 5 kc	20 cps to 10kc	10 cps to 20cps	5 cps to 10 cps	10 kc to 20 kc	20 kc to 100 kc
0.5 to 500	±0.1%	±0.15%	±0.5%	±2%	±0.3%	-
0.001 to 0.5	±(0.1% + 25uv)	±(0.15%+25uv)	±(0.5% + 25uv)	±(2% + 25uv)	±(0.3% + 25uv)	-
0.05 to 50	-	-	-	-	-	±1%

RANGE:

For DC Measurements

Input Voltage Range	Null Range	Input Resistance per volt of input voltage	
		At Null	1% of Full Scale Off Null
50-500	10-0-10	Infinite	100 Meg
	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
5-50	1-0-1	Infinite	1,000 Meg
	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
0.5-5	0.1-0-0.1	Infinite	10,000 Meg
	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg
0-0.5	0.01-0-0.01	Infinite	100,000 Meg
	0.001-0-0.001	Infinite	100,000 Meg

For AC Measurements

Input Voltage Range	Recommended Null Range	Input Impedance
50-500	100-0-100	1 Meg, 35 uuf
	10-0-10	1 Meg, 35 uuf
	1-0-1	1 Meg, 35 uuf
5-50	10-0-10	1.1 Meg, 35 uuf
	1-0-1	1.1 Meg, 35 uuf
	0.1-0-0.1	1.1 Meg, 35 uuf
0.5-5	1-0-1	1 Meg, 50 uuf
	0.1-0-0.1	1 Meg, 50 uuf
	0.01-0-0.01	1 Meg, 50 uuf
0.001-0.5	0.1-0-0.1	1 Meg, 50 uuf
	0.01-0-0.01	1 Meg, 50 uuf
	0.001-0-0.001	1 Meg, 50 uuf

RESOLUTION:

Voltage Readout Dial Resolution

Range Setting	Null Setting	Resolution
500	any	10 mv
50	any	1 mv
5	any	0.1 mv
0.5	any	0.01 mv

Meter Resolution
(1/4 of a small scale meter division)

Polarity Setting	Range Setting	Null Setting	Resolution
DC	any	10	50 mv
DC	any	1	5 mv
DC	any	0.1	0.5 mv
DC	any	0.01	0.05 mv
DC	any	0.001	0.005 mv
AC	500	1	500 mv
AC	500	0.1	50 mv
AC	50	1	50 mv
AC	500	0.01	5 mv
AC	50	0.1	5 mv
AC	5	1	5 mv
AC	50	0.01	0.5 mv
AC	5	0.1	0.5 mv
AC	0.5	1	0.5 mv
AC	5	0.01	0.05 mv
AC	0.5	0.1	0.05 mv
AC	0.5	0.01	0.005 mv

AS A VACUUM TUBE VOLTMETER

ACCURACY: 3% of full scale

RANGE:

Voltage Ranges		Input Impedance
DC:	500-0-500	50 Meg
	50-0-50	50 Meg
	5-0-5	50 Meg
	0.5-0-0.5	50 Meg
	10-0-10*	10 Meg
	1-0-1*	10 Meg
	0.1-0-0.1*	10 Meg
	0.01-0-0.01*	10 Meg
	0.001-0-0.001*	1 Meg
AC:	0-500	1 Meg, 35 uuf
	0-50	1 Meg, 35 uuf
	0-5	1 Meg, 50 uuf
	0-0.5	1 Meg, 50 uuf
	0-100**	1 Meg, 35 uuf
	0-10**	1 Meg, 35 uuf
	0-1**	1 Meg, 35 uuf
	0-0.1**	1 Meg, 35 uuf
	0-0.01**	1 Meg, 50 uuf
	0-0.001**	1 Meg, 50 uuf

*These ranges are obtained by using Null ranges with all five voltage readout dials set to 0.

**These ranges are obtained by the proper setting of the range and null switches with all five voltage readout dials set to 0.

GENERAL SPECIFICATIONS

REGULATION AND STABILITY OF 500 VOLT SUPPLY:

±0.0025% for a ±10% line change
±0.005% per hour after 30 min. warmup

STABILITY OF METER ZERO:

±0.25% of full scale for a ±10% line change

TERMINAL LINEARITY OF KELVIN-VARLEY DIVIDER:

±0.0002% (2ppm) from 0 to 0.1 of full scale
±0.0002% to ±0.002% (2 ppm to 20 ppm) from 0.1 full scale to full scale

OPERATING TEMPERATURE RANGE:

Within DC accuracy specifications from 55°F to 95°F, derated at 0.0004%/°F outside these limits to 35°F and 110°F

Within AC accuracy specifications from 55°F to 95°F, derated outside these limits to 35°F and 110°F as follows:

±0.003%/°F up to 10 kcps
±0.005%/°F above 10 kcps

STORAGE TEMPERATURE RANGE:

10°F to 130°F

RELATIVE HUMIDITY:

Within specifications from 0 to 80% relative humidity

SHOCK AND VIBRATION:

Meets requirements of MIL-T-945A

INPUT POWER:

115/230 VAC ±10%, 50 - 400 cps, approximately 80 watts

SIZE:

Cabinet: 13" high x 9-3/4" wide x 16" deep
Rack: 7" high x 19" wide x 15-1/2" deep

WEIGHT:

Cabinet: Approximately 35 lbs.
Rack: Approximately 32 lbs.

SECTION II

OPERATING INSTRUCTIONS

2-1. CONTROLS, TERMINALS, AND INDICATORS

The location, circuit symbol, and a functional description of external controls, terminals, and indicators on the 823A Precision AC/DC Differential Voltmeter may be found in figure 2-1.

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTION DESCRIPTION
Input terminals	Front panel	J1, J2	Provided for connecting AC or DC voltage to be measured.
Chassis ground terminal	Front panel	J3	Provided for grounding purposes. A 0.47 uf capacitor is connected from the lower input binding post to the chassis ground post. The upper input post should never be connected to the chassis ground post. Since the instrument is equipped with a three-wire line cord with the third wire fastened to the chassis, the external circuit should be checked for conflicts in grounding before connecting lower input binding post (middle post) to the chassis post.
Power toggle switch	Front panel	S1	Applies AC line voltage to the primary circuit of the power transformer.
OPERATE-CALIBRATE switch	Front panel	S4	Remains in the OPERATE position at all times except when it is necessary to calibrate the internal 500 volt DC reference supply. When held in the CALIBRATE position, a representative sample of the reference voltage is compared to the voltage of an internal standard cell and any difference is indicated on the meter.
CALIBRATE control	Front panel	R12	Varies the output of the 500 volt DC reference supply. When the OPERATE-CALIBRATE switch is held in the CALIBRATE position, the reference supply is accurately set by adjusting the CALIBRATE control for zero meter deflection.
RANGE switch	Front panel	S2	Selects desired voltage range. Full scale voltage ranges of 500, 50, 5, and 0.5 volts are available. It also indicates the AC NULL MULT for each range position.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS (sheet 1 of 2)

CONTROLS TERMINALS AND INDICATORS	LOCATION	CIRCUIT SYMBOL	FUNCTIONAL DESCRIPTION
NULL switch	Front panel	S3	Set to VTVM for determining the approximate value of unknown voltage prior to differential measurements. Five null switch ranges of 10, 1, 0.1, 0.01, and 0.001 volts are used for differential measurements. For the DC mode, the null ranges represent full scale differences between the unknown voltage and the amount of precision internal reference voltage that is set on the voltage readout dials. For the AC mode, the null range used times the applicable AC Null Multiplier, indicated by the range switch, represents the full scale difference between the unknown voltage and the amount set on the voltage dials.
A, B, C, D, and E voltage readout dials	Front panel	S6, S7, S8, S9, S10	Provide an in-line readout of the amount of internal reference voltage necessary to null the unknown voltage.
Decimal lights	Front panel	DS1, DS2, DS3, DS4	Serve as decimal points for the voltage readout dials. A different light illuminates for each position of the RANGE switch.
AC - DC polarity switch	Front panel	S5	Selects the AC, + DC, or - DC mode of operation. With this switch in the positive position, the polarity of the upper input binding post is positive with respect to the lower input binding post (middle post).
Output terminals	Rear panel of cabinet models, front panel of rack models	J4, J5	Provided for attaching a recorder to monitor voltage excursions.
Output level control	Rear panel of cabinet models, front panel of rack models	R1	Varies the output level of the output binding post from 0 to at least 18 millivolts full scale deflection.
Meter	Front panel	M1	Indicates approximate voltage when 823A is in VTVM mode and difference between unknown and internal reference voltage when 823A is in differential mode. The upper scale, 500-0-500, is used when the NULL switch is set to VTVM at all other times, the lower scale, 1-0-1, is used.
Mechanical zero control	Meter case	None	Sets meter to zero mechanically. This adjustment should be used only after instrument has been turned off for at least three minutes or when the internal meter terminals have been shorted.
Fuse	Rear panel of cabinet models, front panel of rack models	F1	Fuse holder protrudes from instrument to provide easy access to the fuse. The fuse is a 1.5 ampere slow blowing type for 115 volt operation and a 0.75 ampere slow blowing type for 230 volt operation.

Figure 2-1. CONTROLS, TERMINALS, AND INDICATORS (sheet 2 of 2)

2-2. ZEROING INSTRUCTIONS

From time to time, it may be necessary to adjust the internal meter zero control. This will normally be done at somewhat more frequent intervals than complete instrument calibration. Proceed as follows:

a. Mechanically zero the meter with the adjustment screw on the front of the meter case. If the instrument is in the case, it must be shut off for at least three minutes prior to this adjustment. If out of case, another method would be to short out the internal meter terminals prior to zeroing.

b. Set power switch to ON and allow a 20 minute warmup period.

c. Set RANGE switch to 5 or 0.5 volts, voltage readout dials to zero, and NULL switch to VTVM.

d. Adjust R232, null detector ZERO ADJ, for zero meter deflection. This control may be reached through the ventilation holes in the cabinet model (see figure 4-3). In the rack model, an identified access hole is provided on the rear panel.

2-3. PRELIMINARY OPERATION

The following procedure prepares the voltmeter for operation:

a. Connect power plug to a 115 volt AC power source. If instrument has been wired for 230 volt operation, connect to 230 volts AC.

NOTE

The round pin on polarized three-prong plug connects instrument case to power system ground. Use three-to-two pin adapter supplied with instrument when connecting to a two-contact receptacle. For personnel safety, connect short lead to a suitable ground.

b. Set controls on 823A voltmeter as follows:

RANGE	500 volts
NULL	VTVM
AC - DC polarity	+ (positive)
all voltage readout dials	0 (zero)
power	ON

c. After a warmup period of at least ten minutes, advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE, and adjust internal 500 volt DC reference supply with CALIBRATE control for zero meter deflection. Release OPERATE-CALIBRATE switch.

2-4. OPERATION AS A DC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, connect unknown voltage to input binding posts. If one side is grounded, always connect it to the lower input post (middle post).

b. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

c. If meter reads to the left, turn AC - DC polarity switch to the negative position. The meter needle will deflect to the right. This is because polarity of unknown voltage is negative.

d. Noting the position of illuminated decimal light, set five voltage readout dials to approximate voltage determined in step b. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage readout dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set NULL switch to successively more sensitive null ranges, as indicated in figure 2-2, and adjust voltage readout dials for zero meter deflection in each null position. When the meter needle indicates to the right, the voltage under measurement is greater than the voltage set on the voltage readout dials. When the indication is to the left, the voltage is less than that set on the readout dials.

f. Read unknown voltage directly from the five voltage readout dials.

INPUT VOLTAGE RANGE	*RECOMMENDED NULL SETTING
50-500	10 then 1 (then 0.1 for voltages from 50 to 100 volts)
5-50	1 then 0.1 (then 0.01 for voltages from 5 to 10 volts)
0.5-5	0.1 then 0.01 (then 0.001 for voltages from 0.5 to 1 volt)
0-0.5	0.01 then 0.001

*Any null range may be used with any input voltage range; recommended settings are those most useful.

Figure 2-2. RECOMMENDED NULL SETTINGS

2-5. OPERATION AS AN AC DIFFERENTIAL VOLTMETER

a. After completing preliminary operation, set AC-DC polarity switch to AC.

b. Connect unknown AC voltage to input binding posts.

c. Turn RANGE switch to lowest range that will allow an on-scale reading and note approximate value of unknown voltage as indicated on upper meter scale.

d. Noting the position of illuminated decimal light, set five voltage dials to approximate voltage determined in step c. For example, if approximate voltage is 35 volts, the decimal light between the B and C voltage dials will be illuminated. Therefore, set A dial to 3, B dial to 5, and C, D, and E dials to 0.

e. Set null switch to 0.1 and then 0.01 volt, adjusting voltage dials for zero meter deflection in each position.
f. Read unknown voltage from the five voltage readout dials.

2-6. OPERATION AS A CONVENTIONAL VTVM

If it is desired to use the instrument as a VTVM only, additional ranges can be made available by converting the NULL ranges to VTVM ranges. This is made possible by setting the voltage readout dials to zero. Proceed as follows:
a. Perform preliminary operation procedures as stated in paragraph 2-3.
b. Consult figure 2-3, and select full scale voltage deflection desired. If the approximate value of the voltage to be measured is unknown, select the 500 volt range initially.
c. Set AC - DC polarity switch, RANGE switch, NULL switch, and voltage dials as indicated for the range selected.
d. Connect voltage to be measured to input binding posts. Deflection to the right indicates that an unknown DC voltage is of positive polarity. An unknown AC voltage will always cause deflection to the right.
e. Read voltage from upper or lower scale as listed in figure 2-3.

2-7. MEASUREMENT OF VOLTAGE EXCURSIONS ABOUT A NOMINAL VALUE

a. After completing preliminary operation as stated in paragraph 2-3, set AC - DC polarity switch to desired position.
b. Connect voltage to be observed to input binding posts. If meter reads to the left, the voltage being measured is negative DC; set polarity switch to the negative position in this case. This will cause meter pointer to deflect to the right.
c. Set RANGE switch to lowest range which will give an on-scale meter indication and note nominal value of voltage indicated.
d. Set the five voltage readout dials to nominal voltage.
e. Turn NULL switch to lowest position that will allow voltage excursions to remain on scale.
f. Read voltage excursions from meter. Note that full scale right and left meter deflections are equal to the NULL voltage setting for DC measurements. For AC measurements, full scale right and left meter deflections are equal to the NULL voltage setting multiplied by the AC NULL MULT indicated by the RANGE setting. Figure 2-4 shows full scale AC deflections for the recommended settings of the range and null switches.

Full-Scale Deflection	AC-DC Polarity Switch	Range Switch	Null Switch	Voltage Readout Dials	Meter Scale
DC:					
500-0-500	+	500	VTVM	No effect	Upper
50-0-50	+	50	VTVM	No effect	Upper
5-0-5	+	5	VTVM	No effect	Upper
0.5-0-0.5	+	0.5	VTVM	No effect	Upper
10-0-10	+	No effect	10	All zero	Lower
1-0-1	+	No effect	1	All zero	Lower
0.1-0-0.1	+	No effect	0.1	All zero	Lower
0.01-0-0.01	+	No effect	0.01	All zero	Lower
0.001-0-0.001	+	No effect	0.001	All zero	Lower
AC:					
0-500	AC	500	VTVM	No effect	Upper
0-50	AC	50	VTVM	No effect	Upper
0-5	AC	5	VTVM	No effect	Upper
0-0.5	AC	0.5	VTVM	No effect	Upper
0-100	AC	500	1	All zero	Lower
0-10	AC	500	0.1	All zero	Lower
		50	1		
0-1	AC	500	0.01	All zero	Lower
		50	0.1		
		5	1		
0-0.1	AC	50	0.01	All zero	Lower
		5	0.1		
		0.5	1		
0-0.01	AC	5	0.01	All zero	Lower
		0.5	0.1		
0-0.001	AC	0.5	0.01	All zero	Lower

Figure 2-3. VTVM RANGES

Range Switch Setting	Null Switch Setting	AC Null Multiplier	Full Scale AC Deflection (in volts)
500	1 0.1 0.01	X100	100 10 1
50	1 0.1 0.01	X10	10 1 0.1
5	1 0.1 0.01	X1	1 0.1 0.01
0.5	1 0.1 0.01	X0.1	0.1 0.01 0.001

Figure 2-4. FULL SCALE AC DEFLECTIONS

2-8. USE OF 823A WITH A RECORDER

Recorder output binding posts and an output level control are provided on the 823A for monitoring the excursions of an unknown voltage from the voltage indicated by the voltage dial settings. If the leakage resistance between the recorder and ground is less than 10,000 megohms, the accuracy of the 823A will be impaired. Also, both input posts of the recorder should be able to stand 500 volts DC to ground. Therefore, the John Fluke Model A-70 Potentiometric Recorder (manufactured by the Texas Instrument Co.) is recommended for this application. Set up the recorder as follows:

a. Connect A-70 recorder to 823A voltmeter with teflon leads as shown in figure 2-5.

CAUTION

Do not ground either of the 823A recorder output terminals or either of the A-70 input terminals. If any of these terminals are grounded, current will be drawn from the 823A Kelvin-Varley voltage divider and the accuracy of the 823A will be completely destroyed.

b. After connecting the recorder, perform preliminary operation as stated in paragraph 2-3.

c. Check for excessive leakage as follows:

(1) Connect a DC voltage to the input of the 823A and differentially measure its potential in a recommended null range.

(2) Alternately connect and disconnect the recorder leads from the output terminals of the 823A while noting the meter needle deflection. More than one-quarter of a small scale division deflection indicates that excessive leakage has been introduced by the recorder. This will impair the accuracy of the 823A voltmeter.

(3) Disconnect the voltage.

d. After the leakage test has been successfully completed, short the input terminals of the 823A.

e. Set switches on the 823A voltmeter as follows:

AC - DC polarity	+ (positive)
RANGE	50
NULL	10
Voltage readout dials	10.000

The 823A meter will indicate full scale deflection. This provides up to at least 18 millivolts at the output terminals depending on the setting of the output level control.

f. Turn the output level control until the recorder deflection obtained is that desired to correspond to full scale deflection of the 823A.

g. Remove the short from the input terminals of the 823A. The 823A and the recorder are now ready for combined use. Proceed as instructed under paragraph 2-7.

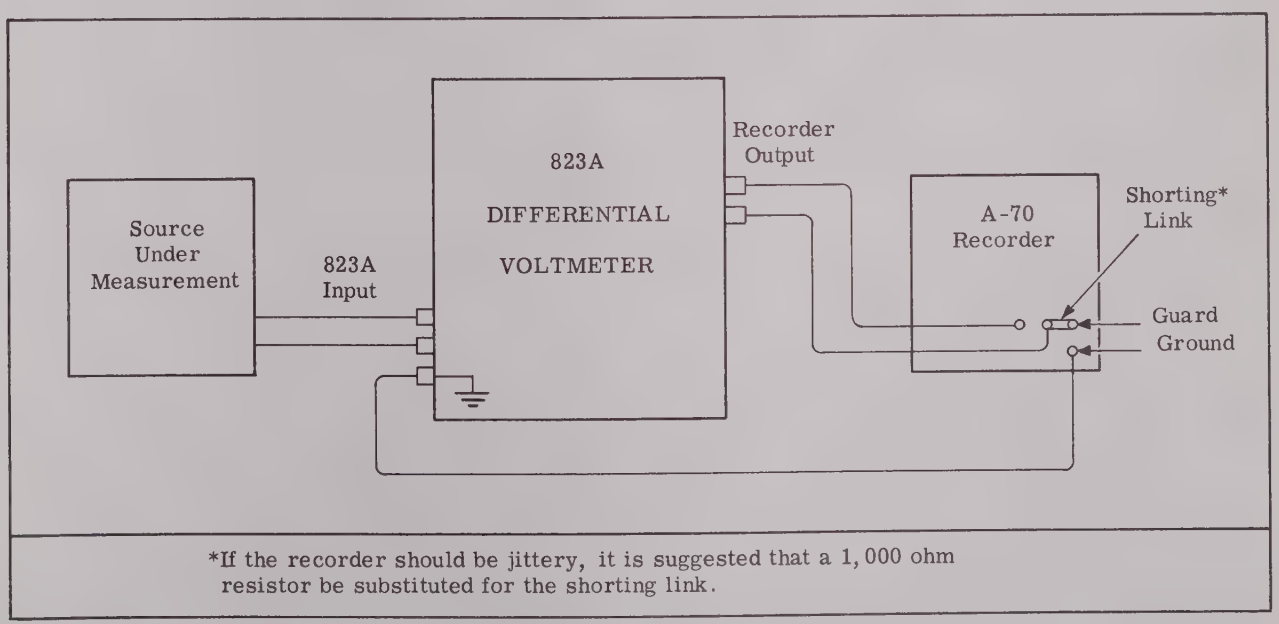


Figure 2-5. RECORDER RECOMMENDED CONNECTION DIAGRAM

2-9. MEASUREMENT OF HIGH RESISTANCES

One of the important features of the 823A voltmeter is its ability to be used as a megohmmeter for rapidly measuring high resistances from 1 megohm to 250,000 megohms. The following equation may be used to compute the resistance in megohms of an unknown connected to the input binding posts:

$$R_x = 10\left(\frac{E}{E_m} - 1\right) \text{ megohms,}$$

where:

R_x = unknown resistance in megohms

E = voltage indicated by voltage readout dials

E_m = voltage indicated on meter

10 = megohms of input resistance of VTVM circuit on 10, 1, and 0.1 null range.

When connecting the unknown resistance to the input terminals, use short isolated leads to prevent measuring leakage resistance between the leads.

a. FROM 1 MEGOHM TO 500 MEGOHMS. For rapid measurement of resistances from 1 megohm to 500 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 10.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 10.00 from the amount set on the voltage readout dials to find the resistance of the unknown in megohms.

b. FROM 500 MEGOHMS TO 5,000 MEGOHMS. For rapid measurement of resistances from 500 to 5,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Subtract 1.00 from the amount set on the voltage readout dials and multiply the result by 10 to find the resistance of the unknown in megohms.

c. FROM 5,000 MEGOHMS TO 50,000 MEGOHMS. For rapid measurement of resistances from 5,000 to 50,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for full scale meter deflection.

(5) Multiply the amount set on the voltage readout dials by 100 to find the resistance of the unknown in megohms.

d. FROM 50,000 MEGOHMS TO 250,000 MEGOHMS. To determine the value of an unknown resistance between 50,000 megohms and 250,000 megohms, proceed as follows:

(1) Perform preliminary procedure as stated in paragraph 2-3.

(2) Set RANGE switch to 500 and NULL switch to 0.1.

(3) Connect unknown resistance between input terminals.

(4) Adjust voltage readout dials for a convenient meter deflection.

(5) The resistance in megohms may be calculated by substituting the meter reading in volts (E_m, 0 to 0.1 volt on bottom scale) and the voltage readout dial setting (E) into the following equation:

$$R_x = 10\,\frac{E}{E_m} \text{ megohms}$$

2-10. NOTES ON MEASURING AC OR DC VOLTAGES

a. ADJUSTMENT OF 500 VOLT REFERENCE SUPPLY. The 500 volt DC reference supply may be adjusted (paragraph 2-3, step c) at any time deemed necessary without heed to the position of the switches and without removing any input or output connections. However, until the instrument has warmed up to an equilibrium temperature (about 1/2 hour), it should be adjusted prior to each specific measurement for best accuracy. When making prolonged measurements, allow one hour warmup time to insure that 500 volt reference supply does not shift during the final warmup phase.

b. GROUND LOOP PRECAUTIONS. Ground loop currents should be avoided to assure accuracy when making measurements. Potential differences are often found at different points on power system grounds. When this is the case, current may flow from the power system ground through the 823A and the equipment under measurement and back to the power system ground. To avoid this when system being measured is grounded, do not connect shorting link from lower input binding post to chassis ground post.

c. USE OF SHORTING LINK. A 0.47 uf capacitor (C1) is connected from the lower input binding post to the chassis ground post to reduce the effect of circulating AC currents from the transformer. In some cases, it is possible for C1 to acquire a charge. For example, C1 will become charged through leakage resistance over a period of time if there is no external connection to the input terminals and the controls are set as follows: range to 500, null to any null range, polarity to +, and voltage readout dials to several hundred volts. This condition may cause an error on low level measurements (under 5 volts) due to C1 discharging through the Kelvin-Varley divider. Connecting the shorting link from the lower input post to the ground post will discharge C1 and thus prevent an inaccurate indication.

2-11. NOTES ON MEASURING DC VOLTAGES

a. RECOMMENDED NULL RANGES FOR DC MEASUREMENTS. Certain null ranges are recommended for use with each setting of the RANGE switch for the following reasons. With the RANGE switch at 500 volts the last voltage readout dial (E) changes the reference voltage in steps of 0.01 volt. Therefore, the unknown voltage would have to be an exact multiple of 0.01 volt if a null is to be obtained on the 0.1 or 0.01 volt NULL range. Furthermore, it is unlikely that an unknown voltage of a few hundred volts will be stable within 10 millivolts. Finally, the regulation of the reference supply is approximately ±0.0025% (±0.0125 volt) for a 10% change in line voltage. Although this is more than adequate when the instrument is used in the recommended way, a badly fluctuating line voltage may cause the 823A to meter the regulation of its own 500 volt reference supply. For example, when measuring 500 volts a line change of 10% may cause the 500 volt reference supply to change as much as 12.5 mv. Although this is small, the 823A will indicate full scale for a change as little as 100 mv or 10 mv if attempting to use the 0.1 or 0.01 null ranges.

b. EFFECT OF AC COMPONENTS ON DC MEASUREMENTS. An AC component of several times the unknown DC may be present on the unknown and the 823A will always indicate well within the specifications for frequencies over a few hundred cycles. An AC component may have an adverse effect if it is of a low frequency or if it has a frequency that is a multiple or submultiple of the chopper frequency. A double section low pass filter (R201, C201, R202, and C202) is used at the input of the null detector to reduce any AC present on the DC being measured. At lower frequencies, this low pass filter is less effective and the magnitude of the AC component is more significant. If this frequency is below 100 cycles, the accuracy may no longer be with specifications. For example, a 60 cycle AC voltage that is 5% of the input voltage will cause an error of approximately 0.005% which is well within the specifications. Also since the input attenuation is less for the more sensitive null settings, the accuracy may be affected only on the more sensitive null settings. When the frequency is very close to a multiple or submultiple of the chopper frequency (approximately 83 cycles), the meter needle will oscillate at the difference frequency. If AC components that affect the accuracy are ever encountered, additional filtering will be required. For an AC of a single frequency, a twin-T filter is effective and has the advantage of low total series resistance. For an AC variable frequency, an ordinary low pass filter may be used. In either case, high quality capacitors of high leakage resistance should be used.

c. MEASUREMENT OF NEGATIVE DC VOLTAGES. Because of a polarity switch, voltages which are negative with respect to ground as well as the more commonly encountered positive voltages may be measured with equal facility. If the upper input post is connected to the metal case or line ground, either at the 823A or at the source under measurement, the accuracy of the voltmeter may be reduced. However, with the polarity switch the upper input post never has to be connected to ground. If the unknown voltage is grounded, always connect the grounded side to the lower input post (middle post) and use the polarity switch to obtain the proper result.

2-12. NOTES ON MEASURING AC VOLTAGES

a. ERRORS DUE TO DISTORTION. The AC to DC converter in the 823A is an average measuring device calibrated in RMS. The converter will put out a DC voltage that is proportional to 1.11 times the average value of the AC input voltage. Thus, if the input signal is not a true sinusoid, the 823A reading is probably in error because the ratio of RMS to average is usually not the same in a complex wave as in a sine wave. The magnitude of the error is dependent on magnitude of the distortion and on its phase and harmonic relationship with respect to the fundamental. Figure 2-6 indicates how the accuracy will be affected by various harmonics for different percentages of distortion. If the distortion present in the signal is composed of even harmonics and is less than 2%, the error between the 823A reading and true RMS is fairly minor. A larger error can occur if the distortion is composed of odd harmonics, especially the third harmonic. Note that for 2% of third harmonic distortion the error in the reading could range from 0 to 0.687%.

Harmonic	% Distortion	% Error From True RMS*	
		Maximum Positive	Maximum Negative
Any even harmonic	0.1	0.000	0.000
	0.5	0.000	0.0001
	1.0	0.000	0.005
	2.0	0.000	0.020
Third harmonic	0.1	0.033	0.033
	0.5	0.167	0.168
	1.0	0.328	0.338
	2.0	0.667	0.687
Fifth harmonic	0.1	0.020	0.020
	0.5	0.099	0.101
	1.0	0.195	0.205
	2.0	0.380	0.420

*Error depends upon phase relationship between harmonic and fundamental, i. e. error can be any value between maximum positive and maximum negative, including zero.

Figure 2-6. PERCENT ERROR DUE TO HARMONIC DISTORTION

b. ERRORS DUE TO GROUNDING. In the 823A there is a 0.47 uf capacitor connected from the lower input terminal (middle post) to chassis ground. If it is desired to make measurements where the voltage to be connected to the lower input terminal is not at ground potential, a line cord adapter must be used to isolate the 823A chassis from line ground. Otherwise, the 0.47 uf capacitor would place an AC load on the circuit being measured.

c. INTERNAL CONVERTER NOISE. When the instrument is shorted in the AC mode, the converter may produce a residual noise output of approximately 100 uv. This noise voltage will cause an insignificant error as long as AC input signals of 1 mv or larger are applied to the instrument. Figure 2-7 shows a typical half wave of the signal voltage at the output of the converter amplifier. It is easily seen that the noise contributes very little to the average value of the signal and is well within the 2.6% accuracy of the instrument at 1 mv.

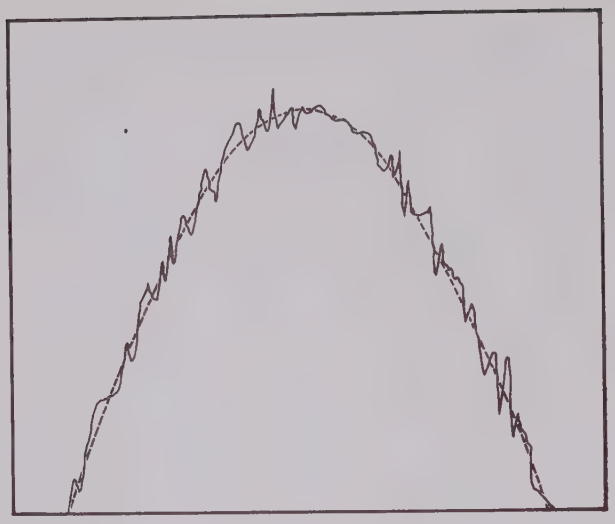


Figure 2-7. SIGNAL VOLTAGE WITH CONVERTER NOISE

d. 0.001 VOLT NULL RANGE ON AC. The 0.001 volt null range should be used with caution when measuring AC voltages. Most AC sources are not stable enough to be used on this range. For example, if 0.5 volt is measured with the range switch set to 0.5 and the null switch set to 0.001, the effective null detector sensitivity is 100 microvolts full scale. Since 100 uv is 0.02% of 0.5 volt, an AC source with a stability worse than ±0.02% will cause the 803D meter pointer to swing from one end of the meter to the other. Also, if the input is shorted with the range switch set to 0.5 and the null switch set to 0.001, the meter needle may deflect more than full scale due to converter noise. However, as pointed out in paragraph 2-12c, converter noise will not impair the accuracy for input signals greater than 1 mv. Thus, any excessive erratic meter needle movement is due to AC source stability.

SECTION III

THEORY OF OPERATION

3-1. GENERAL

a. Figure 3-1 shows the block diagram for the 823A AC/DC Differential Voltmeter. As seen in this figure, the circuit consists basically of an AC to DC converter, a DC vacuum tube voltmeter (vtvm), and a 0 to 500 volt DC reference supply. Refer to the functional schematic following section VI for more detail. This schematic is designed to aid in the understanding of circuit theory and troubleshooting. The signal flow is from left to right and the components are laid out in a functionally logical manner.

b. The overall operation of the 823A may be summarized as follows. To measure the approximate value of a DC voltage, the unknown voltage is connected directly to the DC vtvm. To accurately measure a DC voltage, the unknown voltage is connected across the series combination of the DC vtvm and the 0 to 500 volt DC reference supply. The reference supply voltage is then adjusted with the five voltage readout dials until it matches the unknown voltage as indicated by the vtvm. All AC measurements are made by first converting the AC input voltage to a DC voltage by means of the AC to DC converter. The 823A then operates essentially the same as for approximate and accurate DC measurements.

c. In order to provide for a more complete understanding of the 823A voltmeter, the following paragraphs describe each section of the circuit in detail.

3-2. DC VACUUM TUBE VOLTMETER

a. GENERAL. The DC vtvm is composed of an attenuator, a null detector, and a meter. The heart of the DC vtvm is the null detector in which the DC signal input is modulated by an electromechanical chopper, amplified by a conventional four stage resistance-capacitance coupled amplifier, rectified by the chopper, and

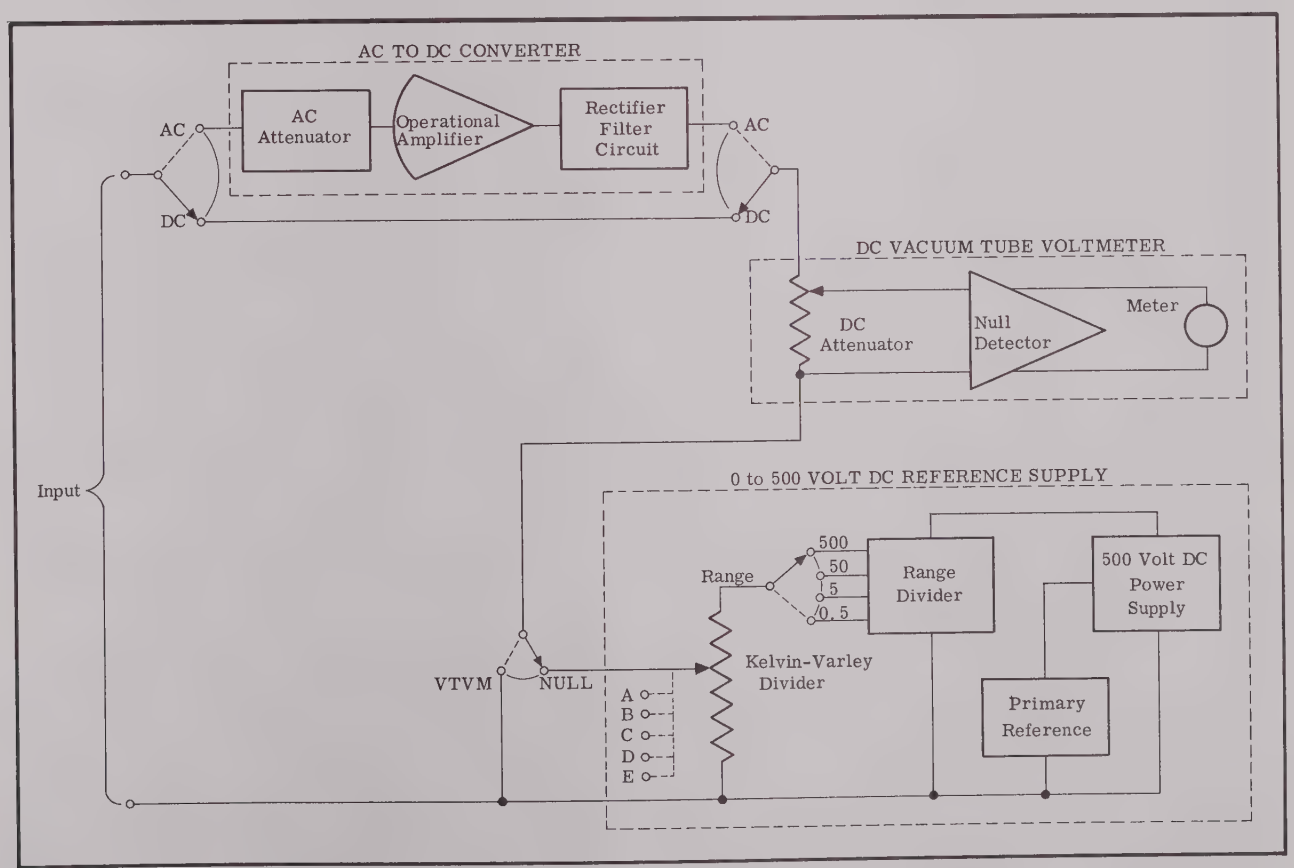


Figure 3-1. 823A AC/DC DIFFERENTIAL VOLTMETER BLOCK DIAGRAM

finally filtered to produce a DC output. The chopper amplifier has a high amount of negative current feedback. This makes the output current approximately equal to the signal voltage divided by the impedance of the feedback network, regardless of the amplifier characteristics. The high negative feedback also makes the amplifier relatively insensitive to the gain changes in individual tubes due to aging and replacement. The output current from the null detector is indicated on a meter that has taut-band suspension. This suspension does away with all friction associated with meter pivot stickiness. Thus, any tendency for the meter pointer to stick at one point of the scale and then jump to another point is completely eliminated. The attenuator is used to reduce the voltage span of each range to a common range usable by the chopper amplifier to produce proper meter deflection.

b. NULL DETECTOR. At the input to the null detector, R201, C201, R202, and C202 form a double section low pass filter that reduces any AC component present on the DC voltage being measured. The difference between the voltage appearing at the output of the filter and the voltage developed across the feedback network is converted to an alternating voltage by G1, an 83 cycle chopper. This chopped voltage is amplified by V202A, V202B, and V203A before passing through cathode follower V203B. During half the chopper cycle the output of the amplifier is clamped to approximate null detector common potential by G1 while during the other half the output is filtered by C212 to provide a DC current for the meter. The voltage developed across feedback network R220, R221, and R222 is proportional to the meter (output) current. When the chopper provides connection between contacts 5 and 7, this feedback voltage effectively reduces the magnitude of the voltage that is chopped and applied to the input of the amplifier. The impedance of the feedback network (R220, R221, and R222) is adjustable between 8.82 and 9.83 ohms. Since the output current is approximately equal to the signal voltage divided by the impedance of the feedback network, a 1 mv signal voltage indicates an output current of 101.7 to 113.4 ua. However, there is a loss due to finite amplifier gain and filtering that leaves the output current around 100 ua which can be set accurately by means of the feedback network. Thus, current feedback makes the output current essentially proportional to the signal voltage. For full scale deflection, a 1 mv signal voltage will cause 100 ua to flow through the meter.

c. INPUT ATTENUATOR. In the DC vtvm mode, four positions on the vtvm attenuator selected by range switch section S2C provide the necessary reduction of the 500, 50, 5, and 0.5 volt ranges for proper chopper-amplifier input. For this mode, the resistance of the attenuator and thus the input resistance of the 823A is 50 megohms (R301 through R310). In the DC differential mode, the voltage difference (unknown voltage minus reference voltage) is reduced by four positions on the vtvm attenuator selected by null switch sections S3C and S3D to give full scale deflections corresponding to inputs of 10, 1, 0.1, and 0.01 volts. For full scale deflection corresponding to 0.001 volt, the voltage across the attenuator is fed directly to the chopper amplifier. Although the resistance of the vtvm attenuator is 10 megohms (R6 through R11) for the 10, 1, 0.1, and 0.01 volt null ranges and 1 megohm (R7 through R11) for the 0.001 volt null range; this is not the input resistance of the 823A. The input resistance is determined by dividing the unknown terminal voltage by the current drawn from the unknown. The current drawn from the unknown is equal to the difference between the unknown terminal voltage and the internally known voltage divided by the resistance of the input attenuator. The equation for input resistance can be hence written as:

$$R_{in} = \frac{E_u}{I_u} = \frac{E_u R_a}{|E_u - E|} = \frac{E_S (R_a + R_S)}{|E_S - E|} - R_S$$ where:

R_{in} = input resistance of voltmeter

E_u = $E_S - I_u R_S$ = terminal voltage of unknown

I_u = current drawn from unknown

E_S = source voltage of unknown

R_S = source resistance of unknown

R_a = resistance of input attenuator

E = voltage indicated by voltage readout dials

$| \ |$ = absolute value (magnitude only)

Since the reference voltage (E) is equal to the unknown voltage (E_u) and the source voltage (E_S) at null, no current is drawn from the unknown and the input resistance is therefore infinite.

d. In the AC vtvm mode, null switch sections S3C and S3D and AC - DC switch section S5F provide connection to only one position on the vtvm attenuator regardless of where the range switch is set. This is because the output of the AC to DC converter is 5 volts DC for full input on each range. In the AC differential mode, the voltage difference (converter output voltage minus reference voltage) is reduced by the same positions on the vtvm attenuator as for DC differential measurements. Because of this and the fact that the converter puts out 5 volts DC for full input on each range, the null range used must be multiplied by the AC null multiplier indicated by the range switch to find the full scale difference between the unknown voltage and the reference voltage. The input impedance for the AC vtvm and AC differential mode depends on the input impedance of the AC to DC converter and its attenuator. The input impedance is thus dependent on the setting of the range switch and is 1 megohm 35 uuf for the 500 volt AC range, 1.1 megohm 35 uuf for the 50 volt AC range, and 1 megohm 50 uuf for the 5 and 0.5 volt AC ranges.

e. NULL DETECTOR POWER SUPPLY. The B+ supply for the null detector is obtained from a half-wave rectifier consisting of diode CR201 and a filter network (C213A, R227, and C213B) that is regulated by an OA2 tube (V204) and series dropping resistor R230. Divider resistors R228, R229, R231, and R232 and diode CR202 provide a compensating voltage for the purpose of adjusting the null detector to zero with R232 when there is no signal input. Diode CR202 keeps one side of R232 at approximately -0.6 volts DC with respect to the null detector common.

f. The filament of V202 and the chopper drive unit require a stable supply. This is obtained by using a filtered half-wave rectifier (CR203 and C214) that drives a Darlington connection of Q201 and Q202. A divider string R234 and R235 uses the B+ supply to obtain approximately 11.8 volts for pin-5 of V202 while pin-4 is maintained approximately 0 volts through the emitter-base junctions of Q201 and Q202. Any change in the half-wave rectifier voltage causes a corresponding change in the voltage across the emitter-collector junction of Q201 so that the filament and chopper voltage remain stable. The filament supply for V203 is obtained from an ordinary 6.3 volt AC winding.

g. EFFECT OF AC COMPONENTS. The only AC voltage component that will reduce the accuracy of the 823A is one that either saturates the chopper amplifier or one that beats with the chopper frequency. Since the voltage required for saturation is greater than that required for beating, the null detector is most sensitive to an AC component with a frequency that is a submultiple or a low multiple of the chopper frequency. However, this is easy to detect because the meter will beat at the difference frequency. The low pass filter at the input of the chopper amplifier will attenuate any AC component. The magnitude of the AC voltage appearing at the output of the filter depends on both is amplitude and frequency before filtering. For all practical purposes, one should never encounter any trouble above a hundred cycles. Below this, the filter may not attenuate the AC component enough. However, this is not as bad as it appears. A 60 cycle AC voltage that is 5% of the input voltage will cause an error of approximately 0.005% which is well within specifications. If AC components that affect accuracy are ever encountered, additional filtering as set forth in paragraph 2-11 will eliminate the problem.

h. GAIN AND ZERO ADJUSTMENTS. Variable resistor R232 in the null detector power supply provides a means of adjusting the output current of the amplifier to zero when there is no input signal. The gain of the amplifier is adjusted by means of R222 in the feedback circuit.

i. RECORDER OUTPUT. The recorder output is picked off divider string R225, R1, and R226. Output level control R1 provides a means of adjusting the output voltage up to a maximum of at least 18 millivolts at full scale deflection. The voltage at the output terminals is proportional to the meter reading.

3-3. 0 TO 500 VOLT REFERENCE SUPPLY

a. GENERAL. When the 823A is used for differential voltage measurements, an internal voltage is nulled or matched against the unknown voltage. An extremely accurate reference voltage is therefore required. This is obtained from the 0 to 500 volt reference supply. The 0 to 500 volt reference supply is composed of a well regulated 500 volt power supply, a range divider, and a Kelvin-Varley five decade attenuator. The output of the 500 volt power supply is applied directly to the Kelvin-Varley attenuator for the 500 volt DC range. In the 50, 5, and 0.5 volt DC ranges, the range divider reduces the voltage to 50, 5, and 0.5 volts before it is applied to the Kelvin-Varley attenuator. For any AC range, the range divider always reduces the voltage to 5 volts. The Kelvin-Varley attenuator divides its input voltage (500, 50, 5, or 0.5 volts) into 50,000 equal increments any number of which may be selected by setting the five decades with the voltage readout dials. The output of the Kelvin-Varley Attenuator, therefore, provides an extremely accurate reference voltage.

b. 500 VOLT POWER SUPPLY. The 500 volt power supply uses three diodes (CR101, CR102, and CR103) and a filter network (R109, R110, C101, and C102) to supply unregulated DC voltage to series passing tube V101. The voltage is regulated by comparing a sample of the output voltage tapped off a divider string (R123, R124, R121, and R12) with the voltage from reference tube V102 in differential amplifier V104. The output of V104 is fed to differential amplifier V105 which drives the grid of series passing tube V101. The control action of the differential amplifiers continuously adjusts the voltage drop across the series passing tube so as to keep the sample voltage equal to the voltage of the reference tube. Any difference in voltage, the error, is amplified by V104 and V105 and thus changes the voltage drop across V101 to maintain the output at 500 volts.

c. For proper operation a highly stable and accurate balance of amplification must be maintained between the two halves of differential amplifier V104. The filament supply for V104 must be regulated to maintain this balance. Regulation is provided by a transistor regulator which supplies constant voltage to the filament of V104. The filaments of the AC to DC converter tubes (V501 and V502) are also supplied by this regulator. A filtered full wave rectifier (CR104, CR105, and C103) which is regulated by a three transistor network (Q1, Q2, and Q3) supplies the regulated DC filament voltage. One side of the filaments are connected to the reference supply common (0 volts) while the other side is maintained at approximately 5.9 volts through the emitter-collector junction of Q3. The output of Q1 drives a Darlington connection of Q2 and Q3. Any variation in the unregulated supply causes a corresponding change in the voltage across the emitter-collector junction of Q3 so that the filament voltage of V104, V501, and V502 remains stable.

d. RANGE DIVIDER. In the 500 volt DC range the output of the 500 volt supply is passed directly to the Kelvin-Varley attenuator by range section S2F. In the 50, 5, and 0.5 volt DC positions, range resistors (R320 through R330) selected by section S2E divide the reference voltage to 50, 5, and 0.5 volts before it is switched to the Kelvin-Varley attenuator by section S2F. With the AC - DC switch set to AC, AC - DC switch section S5E provides connection to the range resistors that divide the reference to 5 volts. This 5 volts is then passed to the Kelvin-Varley attenuator by section S5D. The voltage applied to the Kelvin-Varley attenuator is always 5 volts for AC because the AC to DC converter always supplies up to a maximum of 5 volts to the vtvm attenuator.

e. KELVIN-VARLEY ATTENUATOR. The five Kelvin-Varley decade resistor strings R401 through R455 and associated voltage dials A through E (S6 through S10)

provide a means of making the four precision voltages (500, 50, 5, and 0.5) adjustable. Note that each string, with the exception of the first, parallels two resistors of the preceding string. Between the two wipers of S6 (voltage dial A) then, there is a total resistance of 40K (80K paralleled by 80K). With the range switch in the 500 volt position, a total voltage of 100 volts DC will appear across these two wipers. Also, there will be 10, 1, and 0.1 volts DC across the wipers of S7, S8, and S9, respectively. Voltage dial E (S10) picks increments of 0.01 volt DC from the last decade. These voltages are reduced by a factor of 10 for each lower voltage range. The Kelvin-Varley resistors are matched for both temperature coefficient and tolerance thus providing an overall attenuator accuracy of 0.002% absolute. With the null switch in any null range, the output of the Kelvin-Varley attenuator is connected in series with the vtvm attenuator thus providing the accurate 0 to 500 volts reference supply required.

f. ADJUSTMENTS. Variable resistor R121 is used during calibration to set the 500 volt supply to 500 volts with calibrate control R12 set at its center of rotation. This allows the reference supply to be adjusted to 500 volts by means of the calibrate control at any time deemed necessary. With the operate-calibrate switch held at calibrate, a fixed percentage of the 500 volt supply is compared to the precise potential of an internal standard cell. Any difference in potential is fed to the null detector to give an indication on the meter so that the 500 volt supply can be set with the calibrate control. The fixed percentage of the reference supply is set accurately during calibration by means of R318. The 50, 5, and 0.5 volt range resistor networks are set accurately during calibration by means of R323, R326, and R329.

3-4. AC TO DC CONVERTER

a. GENERAL. The AC to DC converter is composed of an attenuator, an operational amplifier, and a rectifier-filter circuit. A diode in the rectifier-filter circuit is used to convert the unknown AC into pulsating DC, which is then filtered to obtain a DC voltage that is proportional to the average value of the AC input voltage. The output however, is calibrated to indicate the rms value of a pure sine wave. An operational amplifier containing three resistance-capacitance coupled amplifier stages with high negative feedback is used to make the rectification characteristics of the diodes linear and stable. The amplifier achieves a midband loop gain of approximately 70 db with a virtually flat frequency response from 20 cps to 10 kc. The high negative feedback makes the amplifier practically noise free and relatively insensitive to gain changes in individual tubes due to aging and tube replacement. At the output to the amplifier, full wave rectification is used to return negative feedback to the grid of the first amplifier tube. The attenuator is used to reduce the AC input voltage by a factor of 10 or 100, as required to restrict the operational amplifier input to 5 volts maximum for full scale inputs of 50 and 500 volts respectively.

b. OPERATION. All AC measurements are made by first converting the AC input voltage to a DC voltage. The converter provides a DC output of 5 volts when full range voltage is applied to the 823A in each AC range. In the 5 volt AC position, range switch sections S2G and S2H connect the input binding posts directly to the converter input. In this case, the converter feedback is of such a value that the DC output voltage is equal to the rms value of the converter input AC voltage. In the 500 and 50 volt AC positions, an input attenuator reduces the unknown AC by a factor of 100 and 10 respectively. The operation of the converter is then the same as for the 5 volt position. In the 0.5 volt AC position, range switch section S2I and section S2J provide connection to feedback resistors that allow the converter to produce an output that is equal to ten times the AC input. Thus, an output of 5 volts DC is provided for full scale input on any AC range.

c. AC NULL INDICATIONS. When making AC differential measurements, the null range used times the applicable AC null multiplier must be used to represent full scale on the 823A meter. This is due to the way that the converter is constructed. For the 500 volt AC range, the converter produces a DC output voltage equal to 1/100 of the AC input voltage. Thus, the AC null multiplier for the 500 volt range position is X100. For example, when the range switch is set to 500 and the null switch is set to 0.01, full scale meter deflection represents a one volt (100 x 0.01) difference between the unknown voltage and the amount set on the voltage readout dials. By similar reasoning, the multipliers for the 50, 5, and 0.5 volt AC ranges are X10, X1, and X0.1, respectively.

d. ADJUSTMENTS. For 0.5 volt converter gain, R536 and R545 at the output of the converter are adjusted. The gain of the amplifier for the 5 volt range is adjusted by means of R542 and R541 in the feedback network. The high frequency response of the amplifier input is adjusted by means of C504 while C519 adjusts the high frequency response of the 0.5 volt feedback circuit. The attenuation of the 500 volt attenuator is adjusted with R535 and R544 and the attenuator high frequency response is adjusted with C501. The attenuation of the 50 volt attenuator is adjusted with R503 and R533 and the attenuator high frequency response is adjusted with C523.

3-5. AC - DC POLARITY SWITCH

a. The AC - DC polarity switch is provided for selecting either the AC or DC mode of operation. When the AC - DC polarity switch is set to AC, the AC to DC converter is switched into the circuit by sections S5K, S5L, S5M, and S5N. Also, sections S5D and S5E are used to switch 5 volts DC to the Kelvin-Varley divider. When in the AC vtvm mode, S5F is used to provide proper attenuation for the DC attenuator.

b. The AC - DC polarity switch may be set to either of two positions, positive or negative, for the DC mode of operation. As seen in figure 3-2, the AC - DC polarity switch does not reverse the input posts when going from the positive to negative DC position. It reverses the meter and the internal reference supply. If the instrument did not contain positive and negative DC positions, the grounded side of any unknown voltage that is negative with respect to ground would have to be connected to the upper input binding post. This would ground the upper post and effectively place C1 (a 0.47 uf capacitor) across the input terminals. Even if C1 was disconnected, there would still be considerable capacitance across the input due to transformer winding capacitance and stray wiring capacitance. With this capacitance across the circuit being measured several problems could arise. The polarity switch provides equal convenience in measuring positive or negative voltages without the occurrence of these problems.

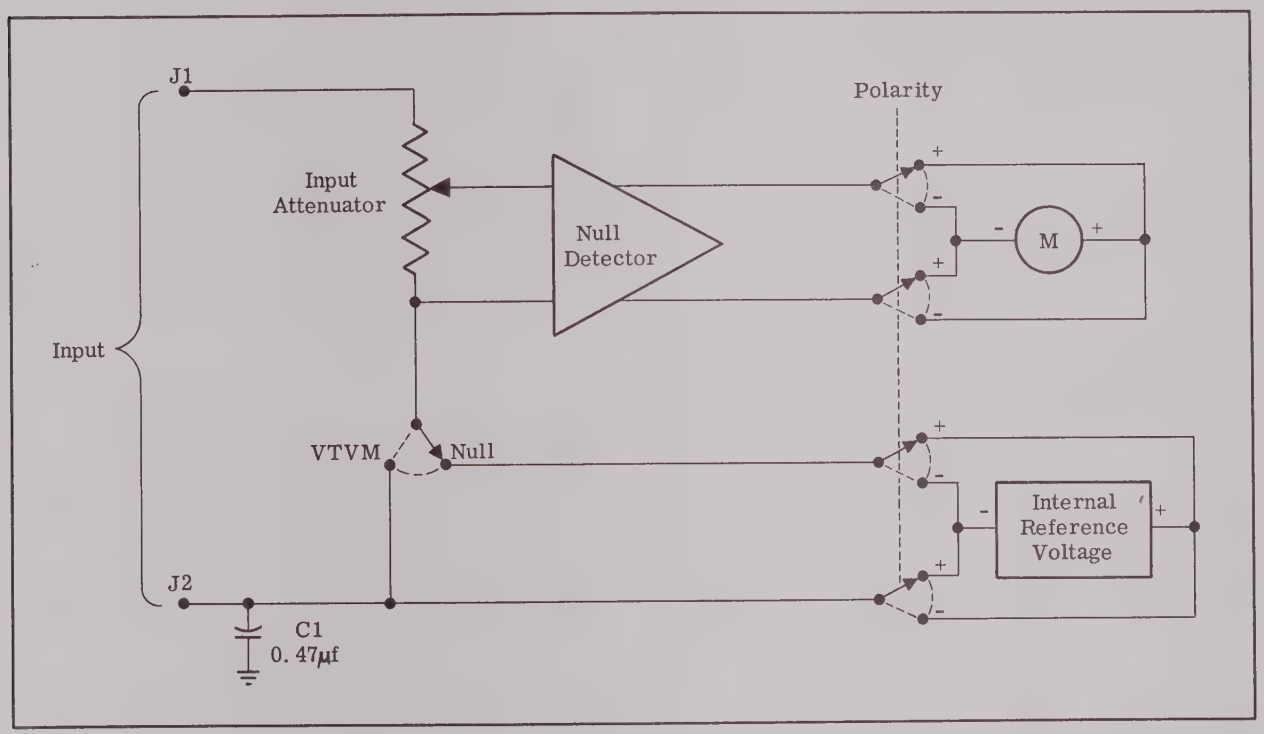


Figure 3-2. FUNCTION OF POLARITY SWITCH

SECTION IV
MAINTENANCE

4-1. GENERAL

The 823A AC/DC Differential Voltmeter seldom requires any maintenance. Without extreme abuse, all that should be required is occasional cleaning, tube replacement and calibration. Periodic maintenance consists only of preventing any leakage as discussed in paragraph 4-2. A discussion of troubleshooting along with a troubleshooting chart, component location diagrams, and a tube voltage chart are provided in paragraph 4-3. Paragraph 4-4 delineates the equipment and procedures necessary to calibrate the instrument.

4-2. PERIODIC MAINTENANCE

a. LEAKAGE PREVENTION. The accuracy of the 823A is adversely affected by excessive electrical leakage from the input of the null detector to either ground or the 500 volt reference supply. Special care has been taken to prevent leakage across certain critical switch wafers and areas of some printed circuit boards due to moisture from condensation. The printed circuit boards have been coated with Humi-Seal 1B12. The range, null, operate-calibrate, and polarity switches have been dipped in Dow Corning silicone oil. Accumulations of dust and foreign matter will cause internal leakage, and should be removed as often as necessary, depending on environmental operating conditions.

b. To check for excessive electrical leakage, proceed as follows:

(1) Perform preliminary operation procedure as stated in paragraph 2-3.

(2) Set switches on 823A as follows:

RANGE	500
NULL	0.1
voltage readout dials	490.00

(3) Remove test leads from input posts.

(4) Excessive leakage is indicated if the meter deflects more than one-tenth of full scale.

c. To prevent excessive electrical leakage, proceed as follows:

(1) Blow the instrument out with low-pressure, clean, dry air to remove most accumulations of dust and foreign matter. Pay particular attention to the binding posts, binding post wiring, critical switches (NULL, RANGE, OPERATE-CALIBRATE, and polarity switches), and the two glass epoxy strips which insulate the null detector chassis from the main chassis.

(2) Clean the glass epoxy strips, binding posts, insulators, and front panel with a rag saturated in anhydrous denatured ethyl alcohol.

(3) When necessary, wash all exposed dielectric surfaces of the NULL, RANGE, OPERATE-CALIBRATE, and polarity switches with denatured alcohol using a small, stiff-bristled brush.

CAUTION

Do not use Metriclene, acetone, lacquer thinner, or any other methyl ethyl ketones, since they will react with the Lexan rotor on the CTS plastic switches.

(4) After washing, recoat the exposed switch insulating material with a solution of Dow Corning 200 having a viscosity between 5 and 20 centistokes. This prevents leakage due to moisture on these surfaces.

d. STANDARD CELL REPLACEMENT. The standard cell should be replaced approximately every three years. As the cell ages, the temperature-voltage hysteresis increases. This necessitates replacement of the standard cell about every three years for instruments used under typical laboratory operating conditions in order to be confident of the 0.01% DC accuracy inherent in the 823A.

4-3. CORRECTIVE MAINTENANCE

a. TROUBLESHOOTING. The purpose of troubleshooting is to quickly and accurately determine the cause of any abnormal condition. To assist in localizing most troubles which might occur, the causes and remedies for a number of symptoms are listed in the troubleshooting chart (figure 4-1). Since failure of the 823A is usually due to tube failure, it is recommended that tube substitution be tried before any other tests are made. However, the 823A is conservatively designed and should require very infrequent tube replacement. At certain times, a check of the pin voltages in the tubes (figure 4-2) is also useful. As an aid to troubleshooting, all components may be located by referring to the figures shown in Section V. An understanding of the theory of operation (Section III) and frequent reference to the schematic diagram will be of great value in troubleshooting.

WARNING

Use extreme care when working inside the instrument while it is on. The null detector chassis and all components thereon will be at a voltage close to that indicated by the voltage readout dials.

SYMPTOM	PROBABLE CAUSE	REMEDY
Drift of the 500 volt DC reference supply evidenced by the continual need for resetting with the CALIBRATE control.	V102, V104, or V105 defective.	Check V102, V104, and V105 by replacement.
	One of the sampling string resistors (R123, R124, R121) is changing value rapidly as the instrument warms up.	Locate faulty resistor by heating slightly with a soldering iron held near the resistor while observing the 500 volt DC calibration.
	Drifting standard cell emf possibly caused by previous shorting or inverting of the cell.	Allow time for the standard cell to stabilize. Several hours should be sufficient.
Cannot calibrate 500 volt DC reference supply.	Excessive aging of V102.	Check V102 by replacement.
Meter cannot be brought to zero with CALIBRATE control.	Out of calibration.	Recalibrate per paragraph 4-4b.
	One or more resistors in 500 volt DC sampling string has shifted in value.	Recalibrate per paragraph 4-4b and observe stability for 48 hours. If 500 volt DC reference supply remains stable, replacement of resistor is unnecessary.
	Standard cell emf has shifted.	Recalibrate instrument and observe stability of reference supply. Replacement of the standard cell may be necessary.
Measurements are out of tolerance on one range other than the 500 volt range.	A reference supply output range resistor on the range resistor printed circuit board is out of tolerance.	If the trouble occurs in the 50 volt range, R324 has shifted; in the 5 volt range, R327 has shifted: in the 0.5 volt range, R330 has shifted. It may be possible to correct by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on all ranges other than the 500 volt range.	R320, R321, or R328 has shifted in value.	It may be possible to correct all range voltages by recalibration. If not, replace faulty resistor.
Measurements are out of tolerance on any range when the Kelvin-Varley divider is dialed to any setting other than 499910.	One of the Kelvin-Varley divider resistors is out of tolerance.	Return to factory for repair and/ or adjustment.
Instrument is out of specifications on all null ranges.	Resistors R6, R7, R8, R9, R10, or R11 out of tolerance.	Check and replace faulty resistor.

Figure 4-1. TROUBLESHOOTING (sheet 1 of 2)

SYMPTOM	PROBABLE CAUSE	REMEDY
Meter rattle, drift, or error is observed on all null ranges.	V202, V203, or V204 faulty. Chopper G1 faulty. Moisture or dirt on printed circuit boards or switches.	Check V202, V203, and V204 by replacement. Replace chopper. Clean instrument.
NOTE: Assuming all DC measurements are normal, the following symptoms are common to AC measurements only.		
Measurements are out of tolerance on 500 volt AC range only.	Out of calibration. One or more resistors in 500 volt AC attenuator has shifted in value.	Recalibrate per paragraph 4-4c. Recalibrate per paragraph 4-4c. Recheck calibration after 48 hours and if attenuator has remained stable, replacement of resistor is unnecessary. If attenuator does not remain stable, or calibration is not possible, replace faulty resistor.
Measurements are out of tolerance on 50 volt AC range only.	Out of calibration. One or more resistors in 50 volt AC attenuator has shifted in value.	Recalibrate per paragraph 4-4c. Recalibrate per paragraph 4-4c. Recheck after 48 hours and if attenuator has remained stable, replacement of resistor is unnecessary. If attenuator does not remain stable or if calibration is not possible, replace faulty resistor.
Measurements out of tolerance on all AC ranges.	Out of calibration. V501 or V502 faulty.	Recalibrate per paragraph 4-4c. Check V501 and V502 by replacement.
Measurements out of tolerance at a specific frequency.	Out of calibration. Faulty frequency compensation capacitor.	Recalibrate per paragraph 4-4c. Locate faulty capacitor and replace. If trouble occurs on all ranges, check C504. If trouble occurs on 500 volt range only, check C501, C502, and C521. If trouble occurs on 50 volt range only, check C523 and C524. If trouble occurs on 500, 50, and 5 volt range, check C520. If trouble occurs on 0.5 volt range check C519.

Figure 4-1. TROUBLESHOOTING (sheet 2 of 2)

b. TUBE REPLACEMENT. Many differential amplifier circuits are critical with respect to the balance between halves of differential amplifier tubes. This is especially true of the first stage of amplification. However, the 823A is designed with the ability to use any 12AX7 for V104 and V105 that meets standard EIA (Electronics Industries Association) characteristics. Some output voltage drift of the 500 volt reference supply may be noted for the first few hours of operation. This drift will, in most cases, decrease to a small value after the tube has aged a bit. Occasionally a tube with a contaminated grid or extremely poor balance between halves will be found. This tube should be discarded. When replacing reference tube V102, the new tube should be aged at least 150 hours to realize the high order of stability inherent in the 823A. A tube that has been aged may be obtained by ordering an 0G3-2 from Fluke.

c. Replacement of tubes will not normally necessitate complete recalibration of the 823A. If V202 or V203 is replaced, calibrate the null detector as set forth in paragraphs 4-4b (1) and 4-4b (2). Replacement of V101, V102, V104, or V105 will necessitate calibration of the reference supply per paragraphs 4-4b (1) and 4-4b (3). If V501 or V502 is replaced, calibrate the AC to DC converter as in paragraph 4-4c.

d. COMPONENT REPLACEMENT. Should it ever become necessary to replace a component on a printed circuit board or on the null detector chassis, proceed as follows:

(1) Clean soldered area around component with methyl ethyl ketone.

(2) Remove part and install new component.

(3) Remove flux with du Pont Freon PC.

(4) Allow to dry for 10 minutes. When it is cool or humid, it may be necessary to place area under a lamp to ensure thorough drying.

(5) Coat any uncoated areas around R2 through R11 on the range resistor board and around the input to the null detector chassis (tube V202, 5751, and chopper) with Humi-Seal 1B12 (manufactured by Columbia Technical Corp. of Woodside, N. Y.).

e. STANDARD CELL PROBLEMS. The standard cell of the 823A deserves special consideration if it is suspected of being faulty:

(1) The standard cell used is a miniature unsaturated cell which has excellent long term stability and negligible, temperature-voltage hysteresis. (Temperature-voltage hysteresis is the erratic behavior of the voltage while the cell is coming to equilibrium following a change in temperature). With time, however, the temperature-voltage hysteresis increases. This necessitates replacement of the standard cell about every 3 years for instruments used under typical laboratory operating conditions. This must be done to be certain that the standard cell quickly settles to a constant and acceptable value after a temperature change. The emf of different cells may vary as much as 0.05% and each instrument is calibrated to its own particular standard cell. Thus, when the standard cell is replaced, the 823A reference supply must be recalibrated as in paragraph 4-4b (3).

(2) Failure of the standard cell may occur if subjected to below freezing temperature. The electrolyte will start to freeze at about $5^{O}F$ and operation below $32^{O}F$ is definitely not recommended. If temperatures below $-10^{O}F$ are encountered for more than 4 hours, it is recommended that the standard cell be replaced. The life of the cell will also be shorter if the cell is operated at elevated temperatures. The 3 year figure holds for operation at normal room temperature, 72 $(\pm 3)^{O}F$.

(3) The emf of the standard cell will change if the cell has been inverted, or if the cell has been inadvertently short-circuited. If the emf has changed, the 823A will naturally be out of calibration on all ranges. In either case, the cell will return to its original emf. If the cell were inverted for only a few seconds, the 823A should be able to measure voltages within specifications after several hours recovery time.

f. DECIMAL LAMP REPLACEMENT. The decimal lamps are normal 6.3 volt lamps. To prolong their life these lamps are operated from a 5 volt transformer winding. However, these lamps do occasionally fail. To replace, proceed as follows:

(1) On cabinet models, remove screws at back of cabinet and slide instrument out of case. If only the upper most decimal lamp needs to be replaced, proceed to step (6).

(2) Remove four screws that hold front panel assembly to chassis.

Symbol & Type	Pin 1	Pin 2	Pin 3	Pin 4	Pin 5	Pin 6	Pin 7	Pin 8	Pin 9
V101, 6BQ5	No Conn.	495	500	Heater voltage 6.3 volts ac		No Conn.	680 to 730	No Conn.	680 to 730
V102, OG3	85	0	Int. Conn.	0	85	Int. Conn.	0	No Pin	No Pin
V104, 12AX7	217	84	86	Heater voltage 5.9 volts dc		217	84	86	See Pin 4 & 5
V105, 12AX7	495	217	220	Heater voltage 6.3 volts ac		500	217	220	
V202, 5751	60	-	0	Heater voltage 12 volts dc		100	-	1.5	No Conn.
V203, 6AW8	47	45	140	Heater voltage 6.3 volts ac		0.7	-	25	50
V204, OA2	150	0	Int Conn.	0	150	Int. Conn.	0	No Pin	No Pin
V501, 6EJ7	1.3	-	1.3	Heater voltage 5.9 volts dc		0	150	93	1.3
V502, 6AW8	28	-	200			1.8	-	100	150 (±50%)

This chart is to be used under the following conditions: (a) RANGE switch set to 500; (b) NULL switch set to VTVM: (c) all voltage readout dials set to zero; (d) polarity switch set to +; (e) line voltage at 115/230 volts, 50-400 cycles; (f) all measurements made with vtvm from negative binding post to specified terminal; and (g) all voltages may vary by 20% unless otherwise indicated.

Figure 4-2. TUBE VOLTAGE CHART

(3) Being careful to avoid wiring damage, gently lift front panel assembly from instrument and set face down in front of instrument.

(4) Remove screws holding range resistor board to front panel assembly.

(5) Push printed circuit board aside enough to allow access to light holders.

(6) Remove light holder from bracket by applying pressure to each side of holder.

(7) Remove cardboard light shield and replace lamp.

(8) On rack models, remove screws holding cover to instrument and set cover aside.

(9) Remove light holder from bracket by applying pressure to each side of holder.

(10) Remove cardboard light shield and replace lamp.

g. TRANSISTOR REPLACEMENT. If it ever becomes necessary to replace one or more of the chopper drive unit transistors (Q701 through Q704), the frequency and symmetry of the output must be reset. Proceed as follows:

(1) After replacing transistors, connect an oscilloscope between the emitter of Q703 and lower input post (middle post) to observe the output waveform.

(2) Adjust R704 until output is within ±3% of symmetry.

(3) Adjust R705 for a frequency of 83 cycles ±2%.

4-4. CALIBRATION

a. GENERAL. The calibration procedure is divided into two main parts: DC differential voltmeter calibration (paragraph 4-4b) and AC to DC converter calibration (paragraph 4-4c). The 823A may be calibrated as often as deemed necessary. However, it is recommended that DC differential voltmeter calibration be done every 6 months. The AC to DC converter calibration should be done every month. For special applications where extreme accuracy is required, it may be desired to calibrate the instrument more often. If subjected to a temperature greater than 130°F or less than 10°F, the instrument should be recalibrated; but, it should be recalibrated no sooner than 24 hours after being removed from the extreme temperature environment. If the instrument is subjected to a temperature of less than -10°F for more than 4 hours, it is recommended that the standard cell be replaced. Calibration should be accomplished in a draft-free area with an ambient temperature of 72 (±3)° F for maximum accuracy under laboratory conditions. The recommended equipment and the specifications required for calibration are shown in figure 4-3. All controls on the cabinet model may be located with the aid of figure 4-4. The instrument must be calibrated in its cabinet. The ventilation holes on the cabinet model provide an easy means of reaching R121, R222, and R232. An insulated screwdriver must be used when adjusting these controls to prevent shorting the control to chassis ground. To reach the calibration controls at the front of cabinet models, the instrument must be slid partly out of its cabinet. On rack models, all controls may be easily reached through labelled access holes.

b. DC DIFFERENTIAL VOLTMETER CALIBRATION. For convenience, the DC differential voltmeter calibration is divided into four parts: preliminary calibration, null detector calibration, reference supply calibration, and range divider calibration. Normally, all four parts are performed in the sequence given here. However, the calibration procedure is written so that any part may be calibrated by performing the procedure for just that part.

RECOMMENDED EQUIPMENT	SPECIFICATIONS REQUIRED
DC CALIBRATION: Fluke 301C or 301E Power Supply Saturated standard cell bank with an accuracy of ±0.001% Voltage reference divider having division ratios of 1, 10, 100, and 1000 with an accuracy of ±0.001% Galvanometer suitable for use with above voltage reference divider	The equipment used must provide 500, 50, 5, and 0.5 volts with accuracy of 0.002%.
AC CALIBRATION: Fluke Model 821A Differential Voltmeter Fluke 301C or 301E Power Supply Krohn-Hite LDS-1500 oscillator Fluke 540A Transfer Standard	The equipment used must provide 500, 50, 5, and 0.5 volts AC at 400 cycles, 10 kilocycles, and 20 kilocycles with an accuracy of at least 0.03% and with less than 0.1% total harmonic distortion.

Figure 4-3. CALIBRATION EQUIPMENT

(1) Preliminary Calibration Procedure.

(a) Set 823A meter to zero with mechanical adjustment screw on front of meter case.

(b) Set switches on 823A as follows:

RANGE	500
NULL	VTVM
AC - DC polarity	+ (positive)
all voltage readout dials	0 (zero)

(c) Set power switch to ON and allow 823A to warm to equilibrium temperature (about 1 hour) inside its case. Meanwhile, proceed with step (d).

(d) Set up necessary equipment to provide DC voltages of 500, 50, 5, and 0.5 volts DC with an accuracy of 0.002%. Proceed as follows: turn on all test equipment and allow it to warm to equilibrium temperature (about 1/2 hour); set proper standard cell voltage on divider; apply 500 volts DC into divider from power supply; set divider to 500 and zero galvanometer by varying output of power supply; voltages of 500, 50, 5, and 0.5 volts DC are made available at output posts by merely changing position of voltage selector switch on voltage divider.

(e) Connect chassis ground binding post to line ground.

(2) Null Detector Calibration.

(a) Perform preliminary calibration procedure as stated in paragraph 4-4b (1).

(b) Adjust null detector ZERO ADJ control R232 until meter indicates zero.

(c) Apply 500 volts DC (±0.002%) to voltmeter.

(d) Adjust VTVM GAIN ADJ control R222 for full scale deflection.

(3) 500 VDC Reference Supply Calibration.

(a) Perform preliminary calibration procedure as stated in paragraph 4-4b (1).

(b) Center CALIBRATE control at its center of rotation.

(c) Set NULL switch to 10 and voltage readout dials to 499.910.

(d) Apply 500 volts DC (±0.002%) to voltmeter.

(e) Adjust 500V ADJ control R121 for a null.

(f) Set NULL switch to 0.1 volt.

(g) Null meter by adjusting CALIBRATE control.

(h) Advance OPERATE-CALIBRATE switch against spring tension to CALIBRATE and null meter by adjusting REF CAL ADJ control R318.

(4) Range Divider Calibration.

(a) Perform preliminary calibration procedure as stated in paragraph 4-4b (1).

(b) Set switches on 823A as follows:

RANGE	50
NULL	0.01
voltage readout dials	49.9910

(c) Apply 50 volts DC (±0.002%) to voltmeter.

(d) Null 823A meter by adjusting 50V DC ADJ control R323.

(e) Set RANGE switch to 5 volts.

(f) Apply 5 volts DC (±0.002%) to voltmeter.

(g) Null 823A meter by adjusting 5V DC ADJ control R326.

(h) Set RANGE switch to 0.5 volts.

(i) Apply 0.5 volts DC (±0.002%) to voltmeter.

(j) Null 823A meter by adjusting 0.5V DC ADJ control R329.

This completes the DC differential voltmeter calibration.

c. AC TO DC CONVERTER CALIBRATION. The DC differential voltmeter section of the 823A must be within specifications before the AC to DC converter can be accurately calibrated. The AC to DC converter must be calibrated in the following order.

(1) Preliminary Calibration Procedure.

(a) Zero instrument as stated in paragraph 2-2.

(b) Check for excessive converter output noise as follows: set RANGE switch to 0.5, NULL switch to 0.01, AC - DC polarity switch to AC, all voltage readout dials to 0 (zero), and power switch to ON; short input terminals of 823A; if the meter needle is not within 150 microvolts (7-1/2 small divisions) of null, converter noise is excessive and the trouble must be corrected before proceeding with calibration; if trouble occurs it is usually the result of the input tube (V501), the filament supply, or the 500 volt supply being noisy. Remove short from input terminals.

(c) Set switches on 823A as follows:

RANGE	500
NULL	0.01
AC - DC polarity	AC
voltage readout dials	499.910

(d) Allow 823A to warm to equilibrium temperature inside its case (about 1 hour). Meanwhile, proceed with step (e).

(e) Set up the necessary equipment to provide 500, 50, 5, and 0.5 volts AC with an accuracy of at least ±0.03% at frequencies of 400 cycles, 10 kilocycles, and 20 kilocycles with less than 0.1% total harmonic distortion. Proceed as follows: connect equipment as shown in figure 4-5; turn on all test equipment and allow it to warm to equilibrium temperature (about 1/2 hour); adjust DC power supply voltage until differ-

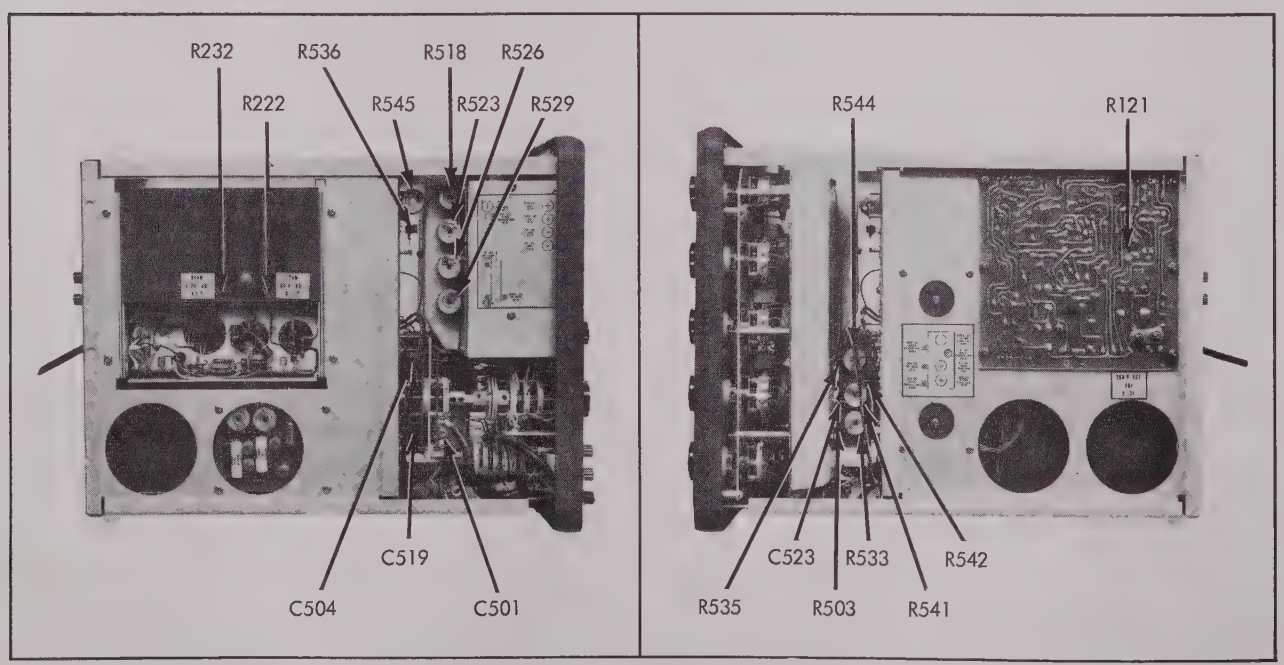


Figure 4-4. ADJUSTMENT LOCATIONS

ential voltmeter indicates rms value of AC voltage required; apply output of DC supply to 540A and null galvanometer by adjusting internal reference supply voltage; apply output of AC oscillator to 540A and null galvanometer by adjusting AC oscillator voltage; the output of the oscillator now equals the required voltage.

(2) 0.5 VAC Converter Gain Adjustment.
(a) Set RANGE switch to 0.5 volt position.
(b) Apply 0.5 volt AC at 400 cycles to voltmeter.
(c) Adjust 0.5 VAC GAIN COARSE ADJ control R536 and 0.5 VAC GAIN FINE ADJ control R545 until meter needle is within ±30 microvolts (1-1/2 small divisions) of null. Use R545 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(3) 5 VAC Converter Gain Adjustment.
(a) Set RANGE switch to 5 volt position.
(b) Apply 5 volts AC at 400 cycles to voltmeter.
(c) Adjust 5 VAC GAIN COARSE ADJ control R542 and 5 VAC GAIN FINE ADJ control R541 until meter needle is within ±300 microvolts (1-1/2 small divisions) of null. Use R541 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(4) 5 VAC High Frequency Adjustment.
(a) Apply 5 volts AC at 10 kilocycles to voltmeter.
(b) Adjust 5 VAC HF TRIM control C504 until meter needle is within ±300 microvolts (1-1/2 small divisions) of needle position noted in (3).

(5) 0.5 VAC High Frequency Adjustment.
(a) Set RANGE switch to 0.5 volt position.
(b) Apply 0.5 volt AC at 20 kilocycles to voltmeter.
(c) Adjust 0.5 VAC HF TRIM control C519 until meter needle is within ±30 microvolts (1-1/2 small divisions) of needle position noted in (2).

(6) 0.5 VAC Converter Gain Check.
(a) Apply 0.5 volt AC at 400 cycles to voltmeter.
(b) If meter needle is not within ±50 microvolts (2-1/2 small divisions) of null, adjust 0.5 VAC GAIN FINE ADJ control R545 and then repeat (3), (4), and (5) before continuing with (7).

(7) 5 VAC Converter Gain Check.
(a) Set RANGE switch to 5 volt position.
(b) Apply 5 volts AC at 400 cycles to voltmeter.
(c) If meter needle is not within ±500 microvolts (2-1/2 small divisions) of null, adjust 5 VAC GAIN FINE ADJ control R541 and repeat (4) and (5) before continuing with (8).

(8) 500 VAC Attenuator Adjustment.
(a) Set RANGE switch to 500 volt position.
(b) Apply 500 volts AC at 400 cycles to voltmeter.
(c) Adjust 500 VAC ATTEN COARSE ADJ control R535 and 500 VAC ATTEN FINE ADJ control R544 until meter needle is within ±30 millivolts (1-1/2 small divisions of null. Use R544 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

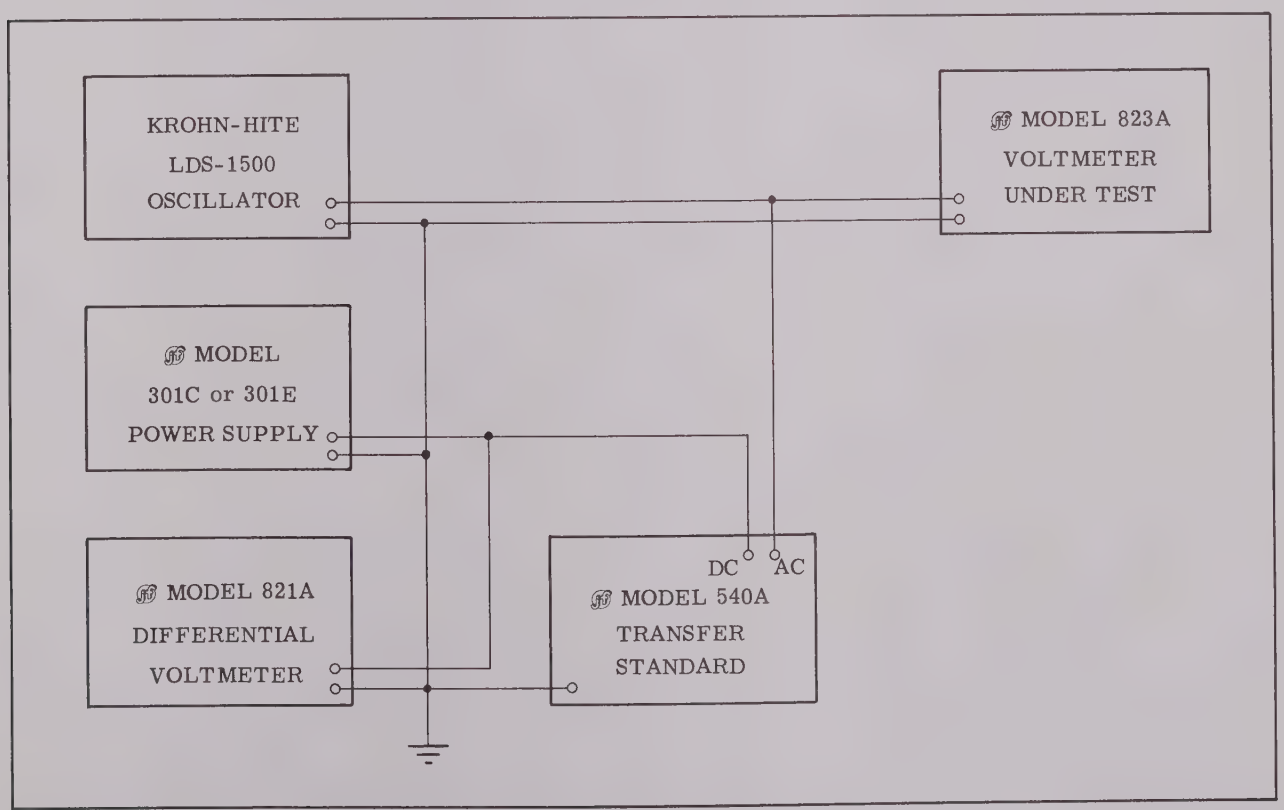


Figure 4-5. AC TO DC CONVERTER CALIBRATION SET-UP

(9) 500 VAC High Frequency Adjustment.

(a) Apply 500 volts AC at 10 kilocycles to voltmeter.

(b) Adjust 500 VAC HF TRIM control C501 until meter needle is within ±30 millivolts (1-1/2 small divisions) of needle position noted in (8).

(10) 500 VAC Attenuator Check.

(a) Apply 500 volts AC at 400 cycles to voltmeter.

(b) If meter needle is not within ±50 millivolts (2-1/2 small divisions) of null, adjust 500 VAC ATTEN FINE ADJ control R544 and repeat (9) before continuing with (11).

(11) 50 VAC Attenuator Adjustment.

(a) Set RANGE switch to 50 volt position.

(b) Apply 50 volts AC at 400 cycles to voltmeter.

(c) Adjust 50 VAC ATTEN COARSE ADJ control R503 and 50 VAC ATTEN FINE ADJ control R533 until meter needle is within ±3 millivolts (1-1/2 small divisions) of null. Use R533 for final touch up trying to keep control in center third of its mechanical range. Note position of meter needle.

(12) 50 VAC High Frequency Adjustment.

(a) Apply 50 volts AC at 10 kilocycles to voltmeter.

(b) Adjust 50 VAC HF TRIM control C523 until meter needle is within ±3 millivolts (1-1/2 small divisions) of needle position noted in (11).

(13) 50 VAC Attenuator Check.

(a) Apply 50 volts AC at 400 cycles to voltmeter.

(b) If meter needle is not within ±5 millivolts (2-1/2 small divisions) of null, adjust 50 VAC ATTEN FINE ADJ control R533 and repeat (12).

This completes AC to DC converter calibration.

SECTION V

LIST OF REPLACEABLE PARTS

5-1. GENERAL

a. The following eight assembly lists describe all normally replaceable parts of the Model 823A and 823AR Differential AC/DC Voltmeters. Each list has a corresponding illustration on which the parts for that list are pointed out. Parts are called out on both lists and illustrations by reference designations from the schematic diagram. Those parts (mechanical) which have no reference designation are shown on the illustrations by Fluke Stock Number.

b. A Use Code column is provided to identify certain parts that have been added, deleted, or modified during production of the 823A. Each part for which a use code has been assigned may be identified with a particular instrument serial number by consulting the Use Code Effectivity List at the end of this section.

5-2. HOW TO OBTAIN PARTS

a. Standard components have been used whenever possible. Thus, most parts may be obtained locally. However, special components are used in some instances. All parts manufactured or altered by Fluke and all parts for which Fluke controls the design are designated by an asterisk preceding the Fluke stock number. All structural parts and special parts should be purchased from your local Fluke representative or from the factory.

b. When ordering parts always include:

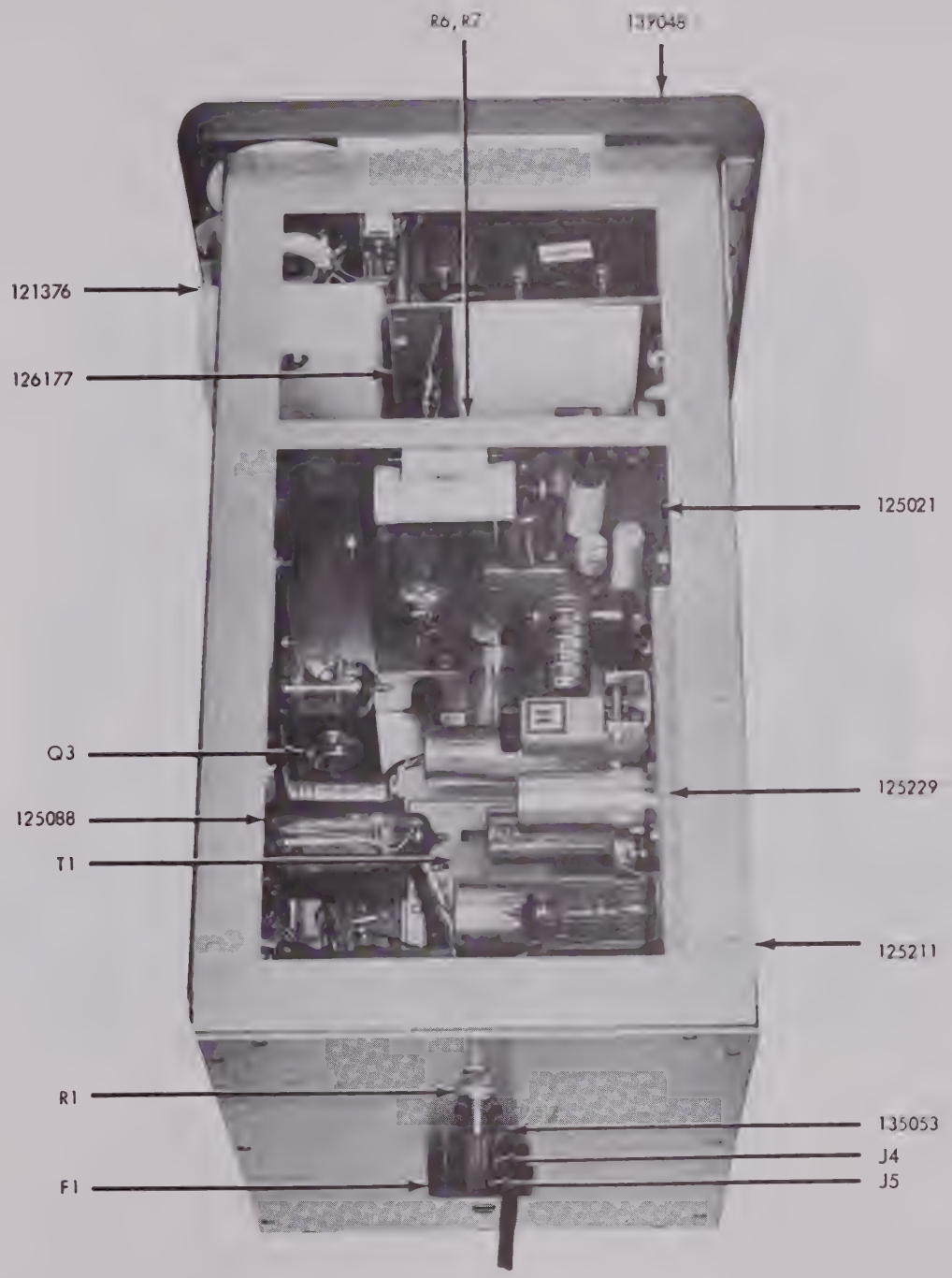
(1) Reference designation, description, and Fluke stock number.

(2) Instrument model and serial number.

(3) Most structural parts are not listed. In this case, give complete description, function, and location for the part.

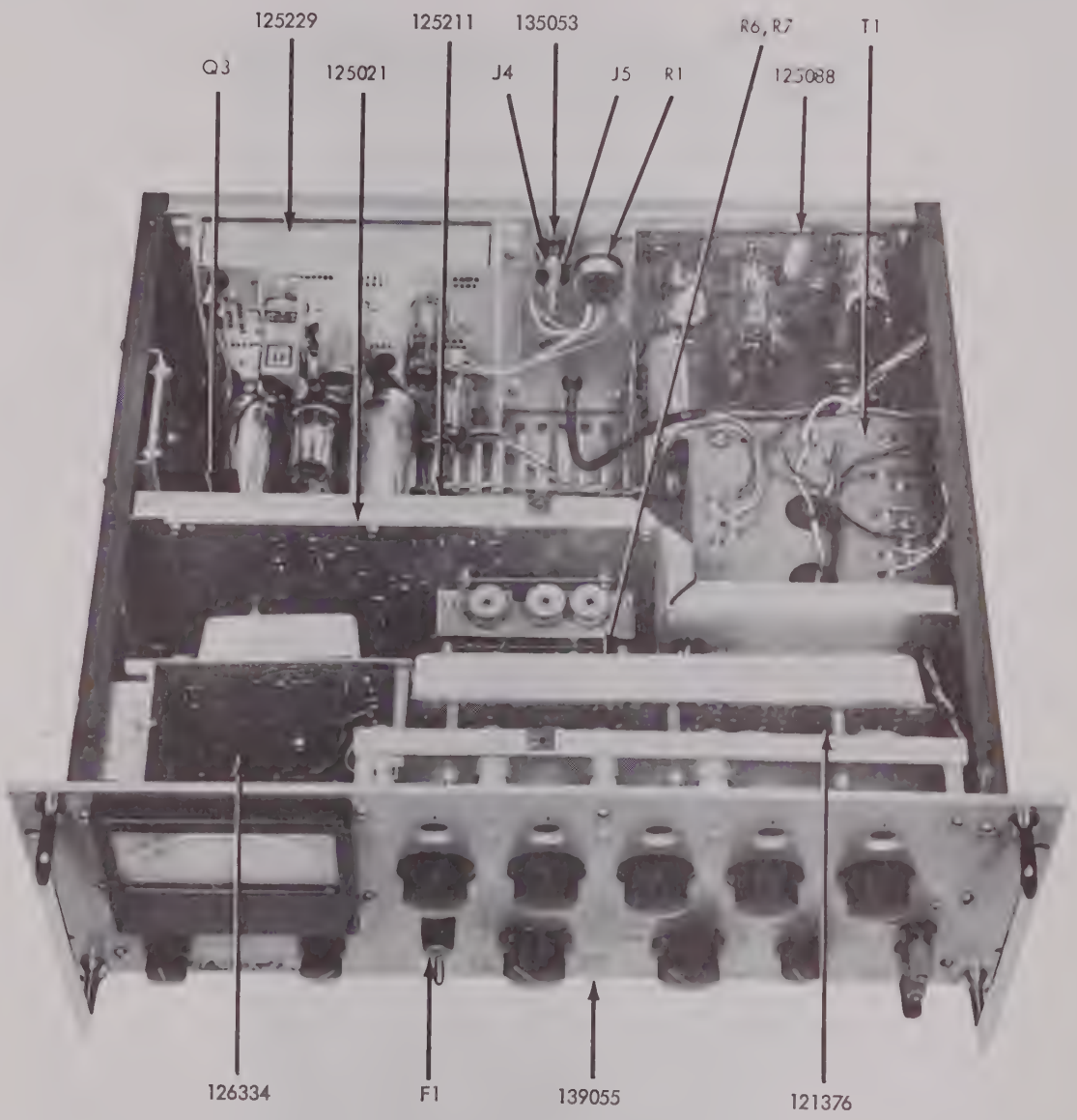
REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Final Assembly (Cabinet model, standard cell option) (Rack model, standard cell option)	 *138792 *138685	
	Front Panel Assembly (See figure 5-2)	*139048 *139055	
	Reference Supply Board Assembly (See figure 5-3)	*125088	
	Null Detector Chassis Assembly (See figure 5-4)	*125229	
	Range Resistor Board Assembly (See figure 5-5)	*126177 *126334	
	Kelvin-Varley Resistor Board Assembly (See figure 5-6)	*121376	
	Converter/AC Range Switch Assembly (See figure 5-7)	*125021	
	Chopper Drive Board Assembly (See figure 5-8)	*125211	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
F1	Fuse, 1.5 ampere, slow blowing (for 115 volt operation)	109306	
	Fuse, 0.75 ampere, slow blowing (for 230 volt operation)	109256	
	Fuse holder	100107	
J4, J5	Binding post, red	104158	
	Binding post insulator, dual, black	*135053	
Q3	Transistor, germanium, PNP, special purpose 2N301W	*116707	
R1	Resistor, variable wirewound, 10K ±10%, 2W	111617	
R6, R7	Resistor, wirewound, 6K ±5%, 5W	113449	
T1	Transformer, power	*121418	
	Line cord, 3 wire	102822	
	Rubber foot	101253	
	Case Assembly (Cabinet model)	*120386	
	Handle, flexible black vinyl, 5-1/2" (Cabinet model)	407-101	



CABINET MODEL

Figure 5-1. FINAL ASSEMBLY (sheet 1 of 2)



RACK MODEL

Figure 5-1. FINAL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Front Panel Assembly	*139048 *139055	
B1	Standard cell	135160	
C1	Capacitor, plastic, 0.47 uf ±10%, 600V	105494	
DS1, DS2, DS3, DS4	Lamp, decimal	102855	
	Light holder	100131	
	Light shield	101428	
	Light lens	103440	
J1, J2	Binding post, red	104158	
	Binding post, insulator, dual, black	*135053	
	Binding post, insulator, black (Cabinet model)	*135061	
	Shorting link	101220	
J3	Binding post, black	101204	
	Binding post, spacer	101212	
M1	Meter, 100-0-100 microamp	*111211	
R2 thru R5	Resistor, carbon film, 10 Meg ±1%, 1W	107748	
R6	Resistor, carbon film, 9 Meg ±1%, 1W	107557	
R7	Resistor, carbon film, 900K ±1%, 1/2W	107391	
R8	Resistor, carbon film, 90K ±1%, 1/2W	107292	
R9	Resistor, carbon film, 9K ±1%, 1/2W	107250	
R10	Resistor, carbon film, 900Ω ±1%, 1/2W	107771	
R11	Resistor, carbon film, 100Ω ±1%, 1/2W	107730	
R12	Resistor, variable wirewound, dual section 1K and 100Ω ±10%, 2W	112714	
S1	Switch, power	114850	
S2	Switch, range, DC section	*125138	
S3	Switch, null	*121293	
S4	Switch, operate-calibrate	*134973	
S5	Switch, AC - DC polarity	*126193	
S6	Switch, voltage dial A	*134817	
S7, S8, S9	Switch, voltage dials B, C, and D	*134841	
S10	Switch, voltage dial E	*134825	
	Knob, 1 inch with pointer	101287	
	Knob, 1-1/2 inch without pointer	101121	
	Knob, 1-1/2 inch with pointer	101311	
	Knob, 1-1/2 inch with index line	103614	
	Voltage dial plates (Cabinet model)	107029	
	(Rack model)	107011	
	Handle, 6" chrome plated (rack model)	101717	

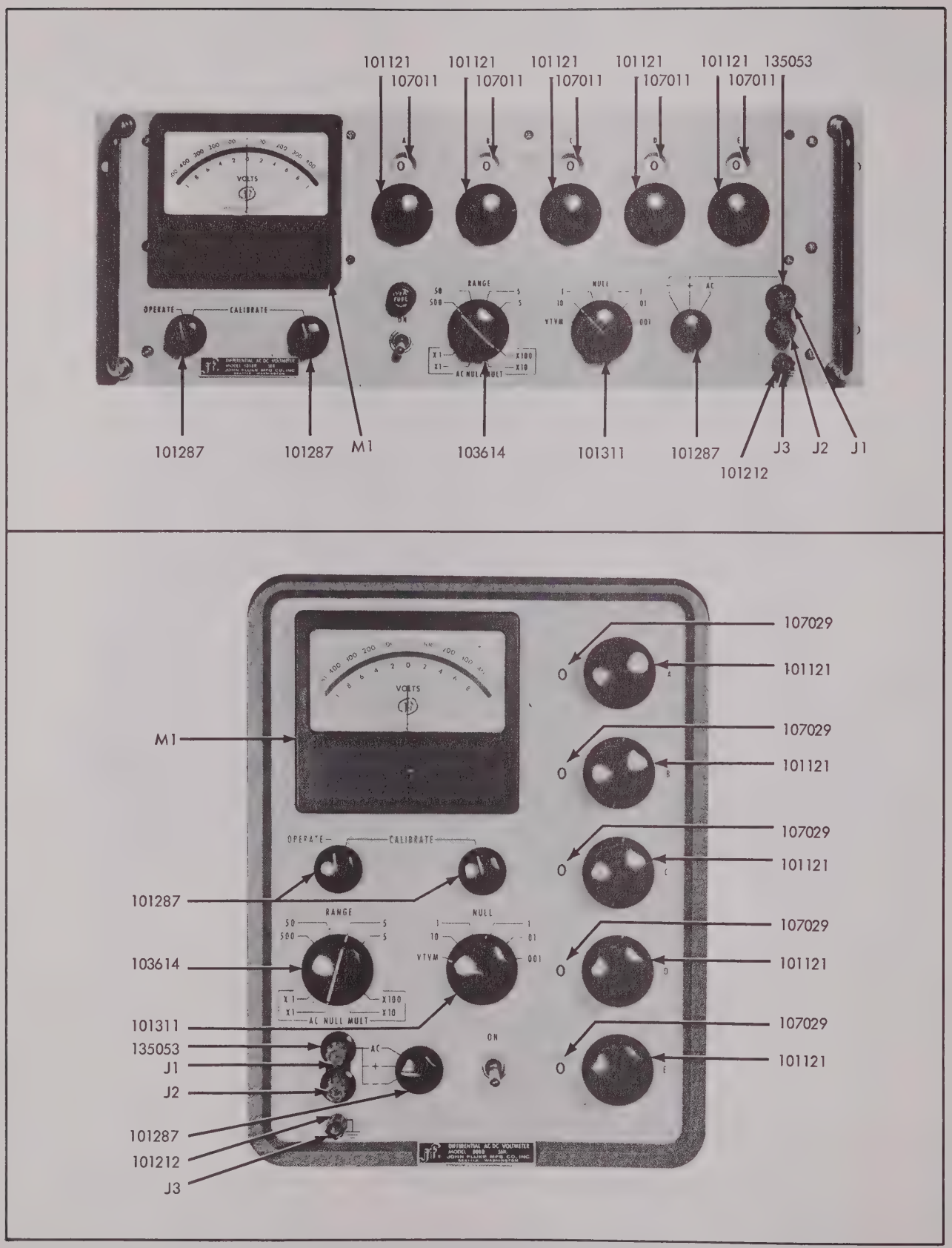
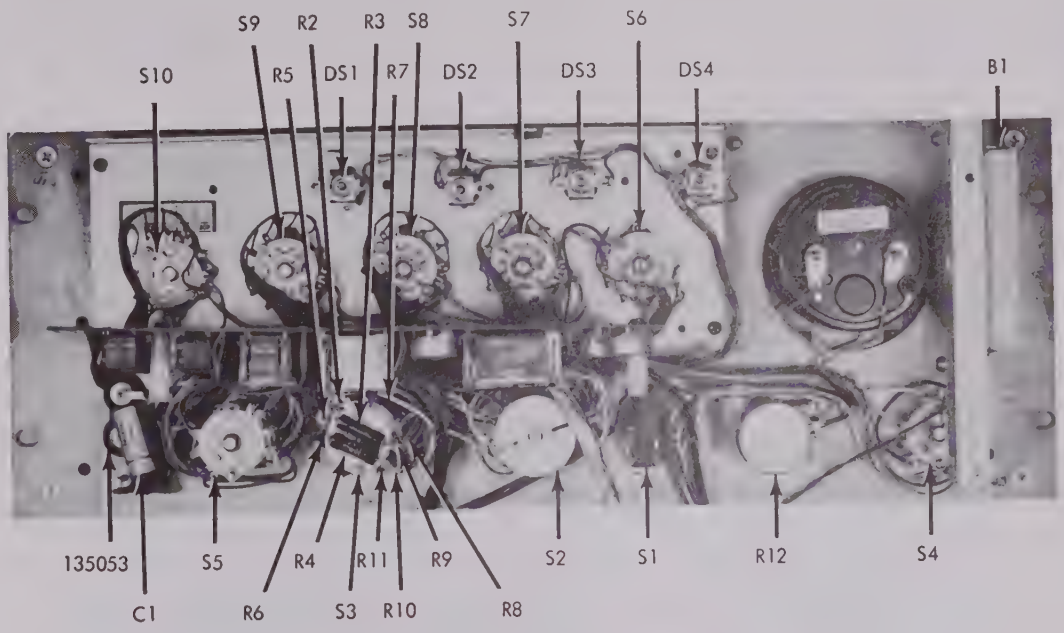


Figure 5-2. FRONT PANEL ASSEMBLY (sheet 1 of 2)



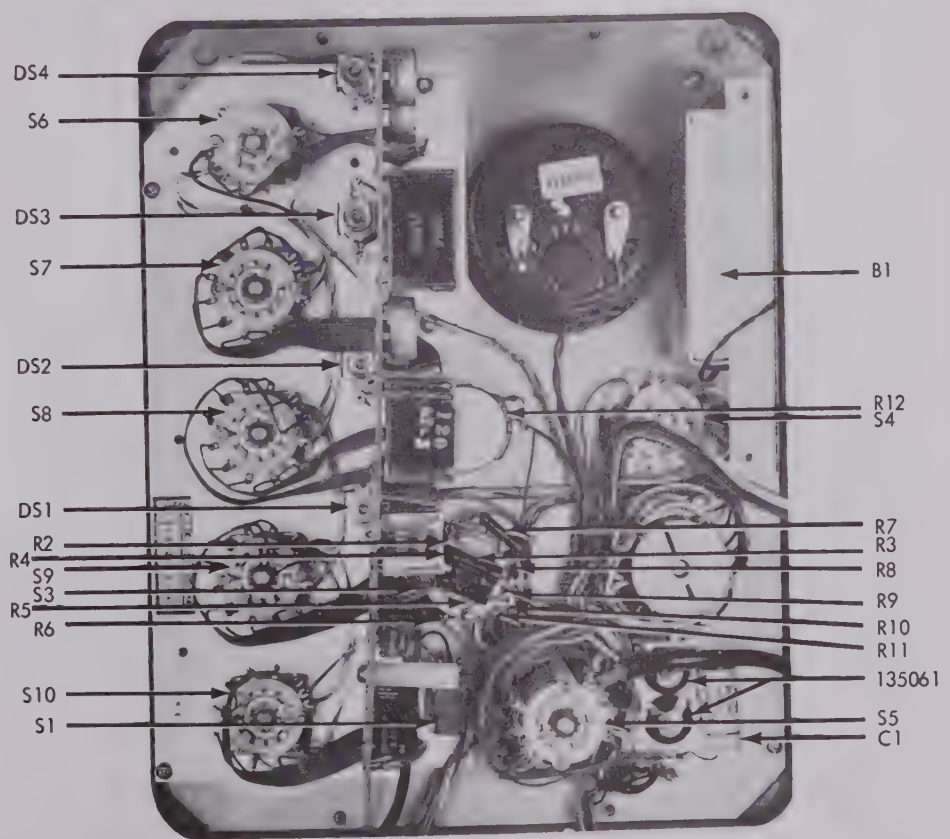


Figure 5-2. FRONT PANEL ASSEMBLY (sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Reference Supply Board Assembly without tubes	*125088	
C101, C102	Capacitor, electrolytic, 20 uf -10/+100%, 500V	105932	
C103	Capacitor, electrolytic, 4000 uf -10/+100%, 15V	105163	
C104	Capacitor, paper, 0.1 uf ±20%, 400V	105312	
C105	Capacitor, plastic, 0.033 uf ±20%, 600V	105916	
C106	Capacitor, plastic, 0.1 uf ±20%, 600V	105833	
C107	Capacitor, ceramic, 0.01 uf -20/+80%, 500V	105668	
CR101 thru CR103	Diode, silicon, 0.750 Amp, 600 PIV	112680	
CR104, CR105	Diode, silicon, 1 Amp, 50 PIV	112409	
Q1	Transistor, germanium, NPN, 2N214 Transistor, silicon, NPN, 2N2712	116137 *117267	A B
Q2	Transistor, germanium, PNP, 2N1372	116129	
R101	Resistor, composition, 1 Meg ±10%, 1/2W	108134	
R102	Resistor, composition, 220K ±10%, 1/2W	108217	
R104	Resistor, carbon film 5K ±1%, 1/2W Resistor, carbon film, 5.44K ±1%, 1/2W	107110 107235	A B
R105	Resistor, carbon film, 135K ±1%, 1/2W Resistor, carbon film, 125K ±1%, 1/2W	107201 107433	A B
R106	Resistor, composition, 8.2K ±10%, 1/2W	109017	
R107, R108	Resistor, carbon film, 50Ω ±1%, 1/2W	107037	
R109, R110	Resistor, composition, 270K ±10%, 1W	109512	
R111	Resistor, composition, 22 Meg ±10%, 1/2W	108233	
R112	Resistor, composition, 15 Meg ±10%, 1/2W	108647	
R113	Resistor, composition, 10 Meg ±10%, 1/2W	108142	
R114	Resistor, composition, 100K ±10%, 1W	109397	
R115	Resistor, wirewound, 140K ±3%, 10W	112417	
R116	Resistor, composition, 100K ±10%, 1/2W	108126	
R117	Resistor, composition, 560K ±10%, 1W	109678	
R118	Resistor, composition, 220K ±10%, 1/2W	108217	
R119	Resistor, composition, 330Ω ±10%, 1/2W	108589	
R120	Resistor, composition, 220K ±10%, 1W	109652	
R121	Resistor, variable wirewound, 5K ±20%, 1-1/4W	111609	
R122	Resistor, composition, 560K ±10%, 1W	109678	
R123	Resistor, wirewound, 386K ±0.5%, 1W	112482	
R124	Resistor, wirewound, 76K ±0.5%, 1/2W	111948	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R125	Resistor, composition, 82K ±10%, 1/2W	108498	
V101	Vacuum tube, pentode, EL84/6BQ5	116616	
V102	Vacuum tube, voltage reference, aged OG3	116749	
V103	Lamp, neon glow, NE2E	100347	
V104, V105	Vacuum tube, duo triode, 12AX7	115956	

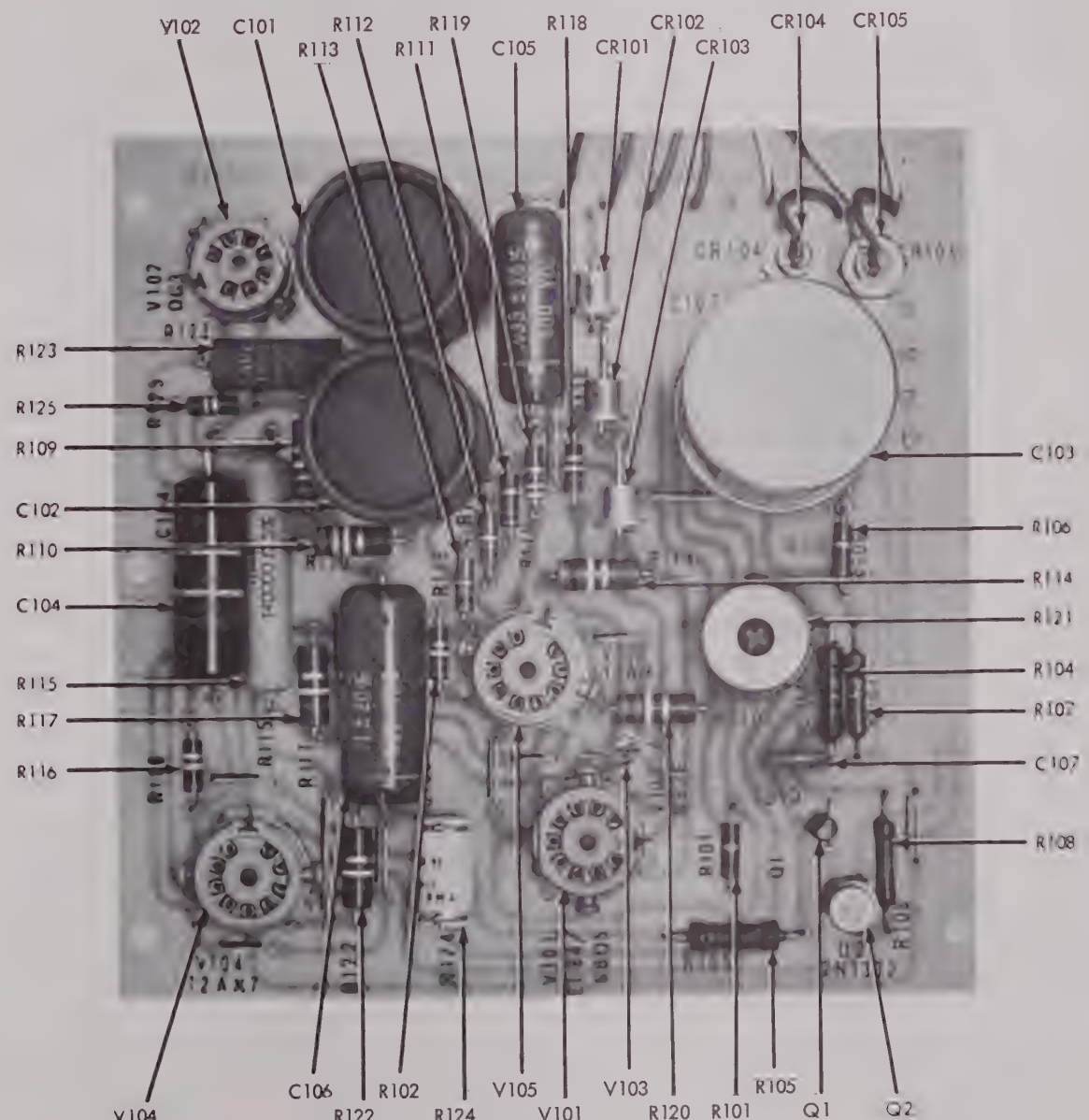


Figure 5-3. REFERENCE SUPPLY BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Null Detector Chassis Assembly without tubes	*125229	
C201, C202	Capacitor, plastic, 0.1 uf ±20%, 100V	106526	
C203	Capacitor, paper, 0.047 uf ±20%, 400V	105718	
C204 ABC	Capacitor, electrolytic, 40-20-20 uf -10/+100%, 250V	106542	
C205	Capacitor, plastic, 0.1 uf ±20%, 200V	106310	C
	Capacitor, plastic, 0.1 uf ±20%, 200V	106435	D
C206	Capacitor, electrolytic, 100 uf -10/+100%, 3V	106534	
C207	Capacitor, ceramic, 0.005 uf ±20%, 500V	105650	
C208	Capacitor, plastic, 0.1 uf ±20%, 200V	106310	C
	Capacitor, plastic, 0.1 uf ±20%, 200V	106435	D
C209	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C210	Capacitor, plastic, 0.1 uf ±20%, 200V	106310	C
	Capacitor, plastic, 0.1 uf ±20%, 200V	106435	D
C211	Capacitor, electrolytic, 5 uf -10/+100%, 50V	106500	
C212	Capacitor, electrolytic, 500 uf -10/+100%, 3V	106328	
C213 AB	Capacitor, electrolytic, 20-20 uf -10/+50%, 450V	105064	
C214	Capacitor, electrolytic, 2000 uf -10/+100%, 25V	105171	
C215	Capacitor, electrolytic, 30 uf -10/+100%, 15V	106492	
C216	Capacitor, electrolytic, 15 uf -10/+150%, 6V	105700	
CR201	Diode, silicon, type IN547, 0.75 Amp, 600 PIV	112680	
CR202	Diode, silicon, type 2E4, 300 ma, 400 PIV	116111	
CR203	Diode, silicon, type IN547, 0.75 Amp, 600 PIV	112680	
CR204, CR205	Diode, silicon, type 2E4, 300 ma, 400 PIV	116111	
G1	Chopper, electromechanical, SPDT	104455	
Q201	Transistor, germanium PNP, special purpose 2N301W	*116707	
Q202	Transistor, germanium PNP, 2N1372	116129	
R201 thru R203	Resistor, composition, 820K ±10%, 1/2W	108357	
R204	Resistor, composition, 2.2 Meg ±10%, 1/2W	108225	
R205	Resistor, composition, 22K ±10%, 1/2W	108209	
R206	Resistor, composition, 150K ±10%, 1/2W	108167	
R207	Resistor, composition, 4.7 K ±10%, 1/2W	108381	
R208	Resistor, composition, 10Meg ±10%, 1/2W	108142	
R209	Resistor, composition, 10K ±10%, 1/2W	108118	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R210	Resistor, composition, 220K ±10%, 1/2W	108217	
R211, R212	Resistor, composition, 1 Meg ±10%, 1/2W	108134	
R213	Resistor, composition, 180K ±10%, 1/2W	108431	
R214	Resistor, composition, 1K ±10%, 1/2W	108563	
R215	Resistor, composition, 3.3 Meg ±10%, 1/2W	108282	
R216	Resistor, composition, 1.5 Meg ±10%, 1/2W	108175	
R217	Resistor, composition, 4.7K ±10%, 1/2W	108381	
R218	Resistor, composition, 22K ±10%, 1/2W	108209	
R219	Resistor, composition, 220Ω ±10%, 1/2W	108191	
R220	Resistor, carbon film, 10Ω ±1%, 1/2W	107789	
R221	Resistor, carbon film, 75Ω ±1%, 1/2W	107045	
R222	Resistor, variable wirewound, 500Ω ±10%, 2W	111773	
R223, R224	Resistor, composition, 1.8K ±10%, 1/2W	108860	
R225, R226	Resistor, composition, 47K ±10%, 2W	110015	
R227	Resistor, composition, 2.2K ±10%, 2W	109967	
R228	Resistor, composition, 560K ±10%, 1/2W	108795	
R229	Resistor, composition, 560Ω ±10%, 1/2W	108316	
R230	Resistor, composition, 2.2K ±10%, 2W	109967	
R231	Resistor, composition, 180K ±10%, 1/2W	108431	
R232	Resistor, variable wirewound, 10K ±20%, 2W	111617	
R233	Resistor, composition, 100K ±10%, 1/2W	108126	
R234	Resistor, carbon film, 2.7K ±1%, 1/2W	107276	
R235	Resistor, carbon film, 31.6K ±1%, 1W	107797	
R236	Resistor, composition, 22K ±10%, 1/2W (may be omitted)	108209	
V201	Lamp, neon glow, type NE2E, 1/10W	100347	
V202	Vacuum tube, duo triode, 5751	116657	
V203	Vacuum tube, triode-pentode, 6AW8A	116434	
V204	Vacuum tube, voltage reference, OA2	115873	
	Vacuum tube shield	101808	
	Vacuum tube clamp, 2 inches high	102178	

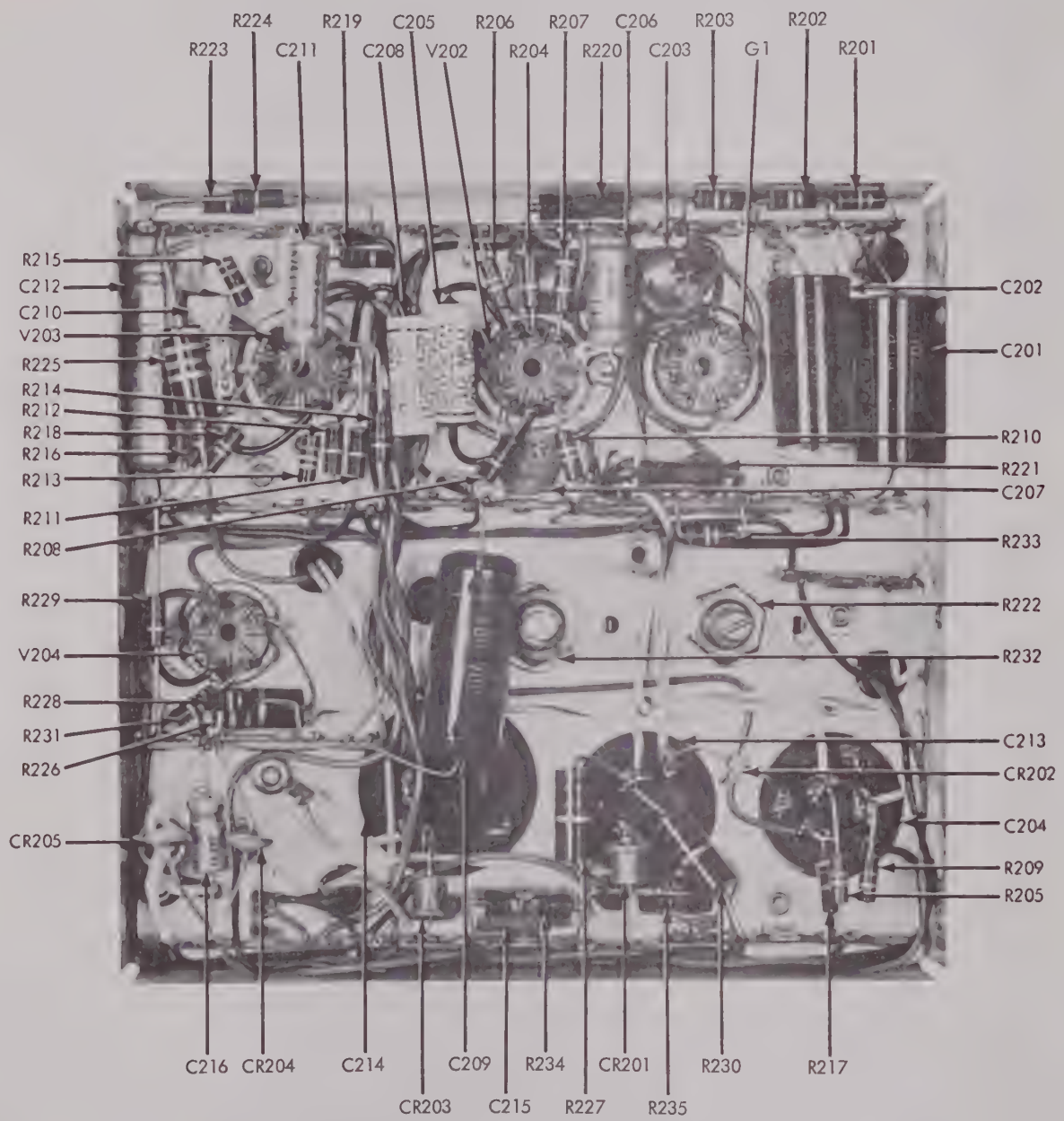


Figure 5-4. NULL DETECTOR CHASSIS ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Range Resistor Board Assembly	*126177 *126334	
C301	Capacitor, plastic, 1 uf ±20%, 600V	105924	
C302	Capacitor, plastic, 2 uf ±20%, 200V	106443	
R311 thru R315	Resistor, composition, 22 Meg ±10%, 1/2W	108233	
R318	Resistor, variable wirewound, 350Ω ±10%, 1-1/4W	113100	
R322	Resistor, composition, 12K ±10%, 1/2W	108977	
R323, R326, R329	Resistor, variable wirewound, 150Ω ±10%, 1-1/4W	113092	
R331	Resistor, composition, 270Ω ±10%, 1/2W	108241	
	Matched Resistor Set	*121400	
R316, R317**	Resistor, wirewound, 74.975K ±0.015%, 1/2W	*131961	
R319**	Resistor, wirewound, 459.8Ω ±0.025%, 1/2W	*132001	
R320, R321**	Resistor, wirewound, 74.975K ±0.015%, 1/2W	*131961	
R324**	Resistor, wirewound, 28.571K ±0.015%, 1/2W	*131979	
R327**	Resistor, wirewound, 2298.8Ω ±0.015%, 1/8W	*131987	
R328**	Resistor, wirewound, 74.975K ±0.015%, 1/2W	*131961	
R330**	Resistor, wirewound, 225.45Ω ±0.015%, 1/8W	*131995	
R332**	Resistor, wirewound, 74.975K ±0.015%, 1/2W	*131961	
	Plastic cover	*121442	

**These resistors are factory matched for each instrument. When ordering, make sure all information called for in paragraph 5-2 is specified.

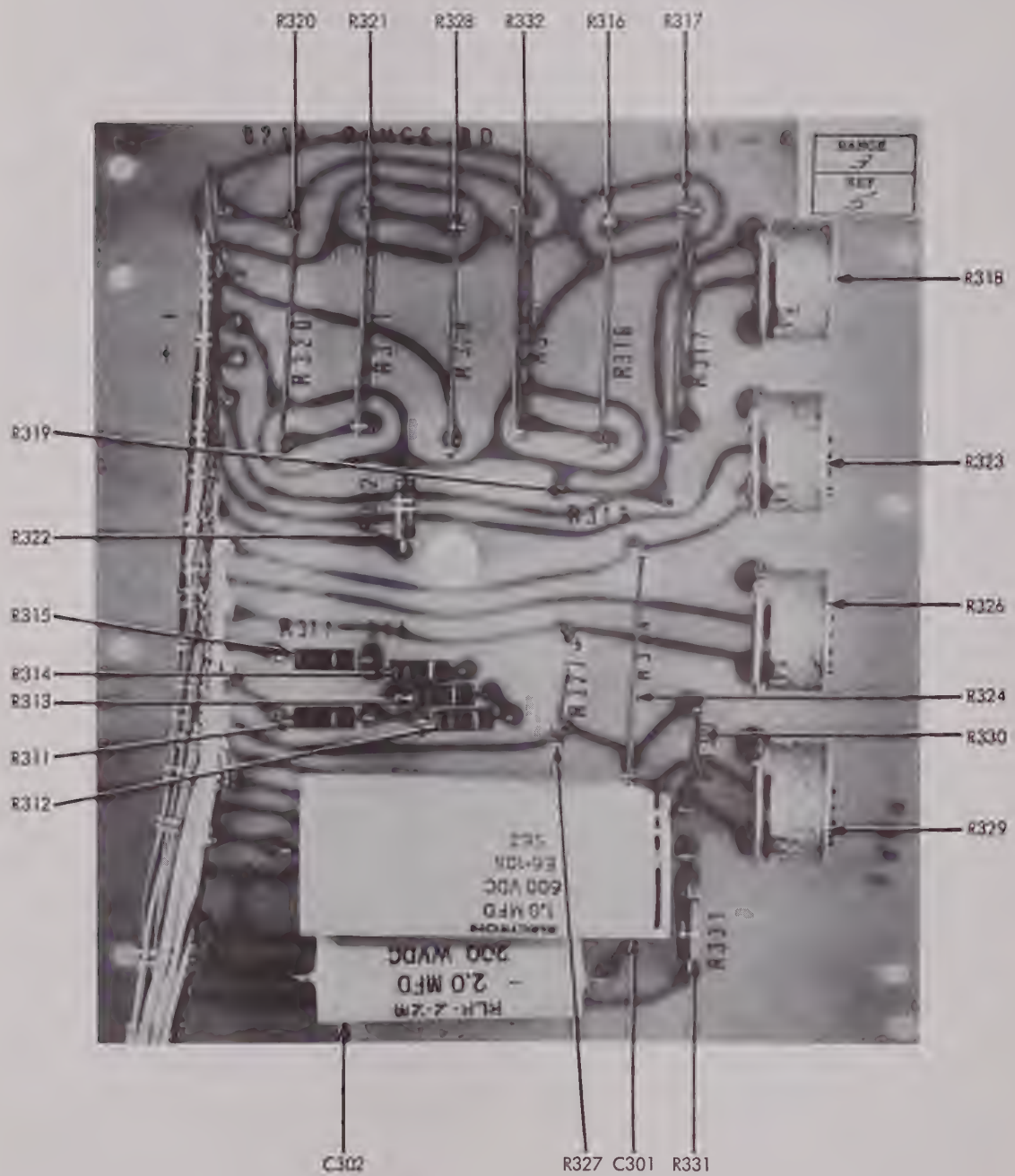


Figure 5-5. RANGE RESISTOR BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Kelvin Varley Resistor Board Assembly	*121376	
R401 thru R406**	Resistor, wirewound 39.996K ±0.005%, 1/2W	*146530	
R407 thru R417**	Resistor, wirewound 8K ±0.005%, 1/2W	*131946	
R418 thru R428**	Resistor, wirewound 1.6K ±0.01%, 1/8W	*131953	
R429 thru R439	Resistor, wirewound 320Ω ±0.1%, 1/2W	*146159	
R440 thru R449	Resistor, wirewound 64Ω ±0.1%, 1/2W	*146167	
R450 thru R455	Resistor, variable wirewound, 10Ω ±20%, 1-1/4W	112672	
	Plastic cover	121491	

**These resistors are factory matched for each instrument. They should be replaced only at the factory.

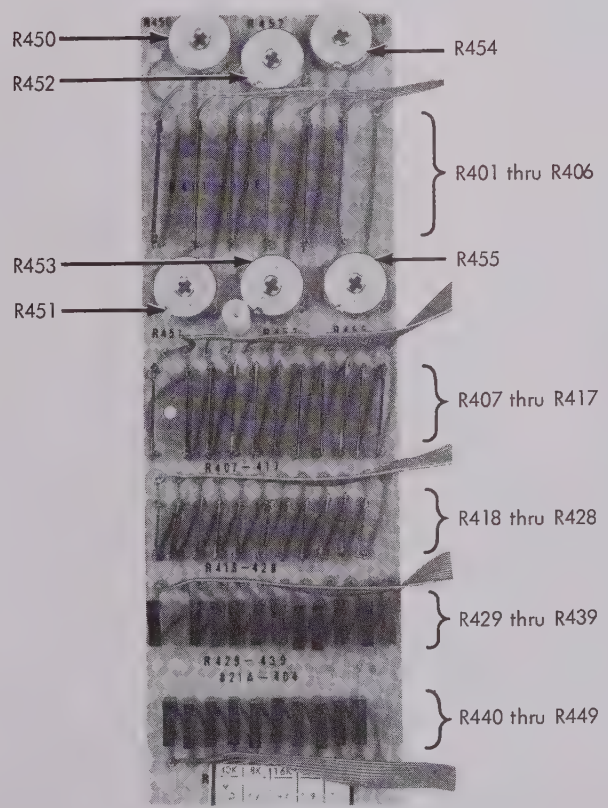


Figure 5-6. KELVIN-VARLEY RESISTOR BOARD ASSEMBLY

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Converter/AC Range Switch Assembly	*125021	
CR501, CR502	Diode, silicon, 60 ma	113274	
	Converter Assembly	*125039	
C505AB	Capacitor, electrolytic, 10-10 uf-10/+50%, 500V	105130	
C506	Capacitor, ceramic, 0.005 uf ±20%, 500V	105650	
C507	Capacitor, ceramic, 300 uf ±10%, 500V	105734	
C508	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C509	Capacitor, plastic, 0.0068 uf ±20%, 400V	106591	
C510	Capacitor, ceramic, 500 uuf -0%, 500V	105692	
C511	Capacitor, plastic, 0.47 uf ±20%, 200V	106419	
C512	Capacitor, paper, 0.1 uf ±20%, 400V	105312	
C513	Capacitor, electrolytic, 20 uf-10/+100%, 50V	106229	
C514	Capacitor, ceramic, 2.2 uf-0%, 3V	106393	
C515	Capacitor, plastic, 2 uf ±20%, 200V	106443	
C516	Capacitor, paper, 1 uf ±20%, 600V	105924	
C517	Capacitor, plastic, 5 uf ±20%, 200V (If replacement is required, it will be necessary to replace 106468 with 106997 and C503, 106740 with 107003)	106468	C
	Capacitor, plastic, 5 uf ±5%, 200V	106997	D
C518	Capacitor, plastic, 2 uf ±20%, 200V	106443	
C522	Capacitor, electrolytic, 500 uf-10/+100%, 3V	106328	
CR503	Diode, silicon, 300 ma, 400 PIV	116111	
R506, R507	Resistor, metal film, 68K ±5%, 2W	111112	
R508	Resistor, metal film, 56K ±5%, 2W	111104	
R509	Resistor, metal film, 100K ±5%, 5W	111195	
R510, R511	Resistor, composition, 3.3K ±10%, 1/2W	108373	
R512	Resistor, composition, 220Ω±10%, 1/2W	108191	
R513	Resistor, composition, 270Ω±10%, 1/2W	108241	
R514	Resistor, composition, 1.8 Meg±10%, 1/2W	108720	
R515	Resistor, composition, 2.2 Meg±10%, 1/2W	108225	
R516	Resistor, composition, 15 Meg ±10%, 1/2W	108647	
R517	Resistor, composition, 18 Meg±10%, 1/2W	108985	
R518	Resistor, composition, 1.8 Meg±10%, 1/2W	108720	
R519	Resistor, composition, 47Ω±10%, 1/2W	108688	
R520	Resistor, metal film, 120K ±5%, 2W	111120	
R521	Resistor, composition, 180Ω±10%, 1/2W	108571	
R522	Resistor, composition, 10K±10%, 1/2W	108118	
R523	Resistor, composition, 390Ω±10%, 1/2W	108365	
R524	Resistor, composition, 330K±10%, 1/2W	108274	
R525	Resistor, composition, 470K±10%, 1/2W	108290	

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
R526	Resistor, composition, 220K±10%, 1/2W	108217	
R527	Resistor, composition, 47Ω±10%, 1/2W	108688	
R528	Resistor, metal film, 150K±5%, 2W	111138	
R529	Resistor, composition, 100K±10%, 1W	109397	
R530	Resistor, metal film, 47K±5%, 5W	111187	
R531	Resistor, composition, 220Ω±10%, 1/2W	108191	
R532	Resistor, composition, 470K±10%, 1/2W	108290	
R536	Resistor, variable wirewound, 500Ω±10%, 1/4W	111781	
R537	Resistor, carbon film, 100K±1%, 1/2W	107185	
R538	Resistor, wirewound, 21.28K ±0.1%, 1/2W	113217	
R539	Resistor, wirewound, 490Ω±0.1%, 1/2W	112805	
R545	Resistor, variable wirewound, 25Ω±10%, 1-1/4W	113431	
V501	Vacuum tube, pentode, 6EJ7	116699	
V502	Vacuum tube, triode-pentode, 6AW8A	116434	
	AC Range Switch Assembly	*125047	
	AC-Range-Switch Gain Adjust Assembly	*125047-1	
R533	Resistor, variable wirewound 100Ω±20%, 1-1/4W	112797	
R541	Resistor, variable wirewound 50Ω±20%, 1-1/4W	112490	
R544	Resistor, variable wirewound 10Ω±20%, 1-1/4W	112672	
	AC-Range-Switch Attenuator Assembly	*125047-2	
C501	Capacitor, variable glass 0.8 to 8.5 uuf, 1250V	106872	
C502	Capacitor, ceramic, 39 uuf ±2%, 600V	105627	
C503	Capacitor, plastic, 0.18 uf ±10%, 600V (If replacement is required, it will be necessary to replace 106740 with 107003 and C517, 106468 with 106997)	106740	C
	Capacitor, plastic, 0.12 uf ±5%, 600V	107003	D
C521	Capacitor, ceramic, 300 uuf ±5%, 600V	105601	
C523	Capacitor, variable glass 0.8 to 8.5 uuf, 1250V	106872	
C524	Capacitor, ceramic, 5 uuf ±10%, 500V	106955	
R503	Resistor, variable wirewound 5K ±10%, 1/4W	111765	
R535	Resistor, variable wirewound 500 ±10%, 1/4W	111781	
	Matched Resistor Set	*107987	
R501	Resistor, metal film, 1 Meg±1/2%, 1W		
R502	Resistor, metal film, 122.6K ±1%, 1/2W		
R534	Resistor, metal film, 10K ±1%, 1/2W		

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	AC-Range-Switch Gain Network Assembly	*125047-3	
C504, C519	Capacitor, variable glass 0.8 to 8.5 uuf, 1250V	106872	
C520	Capacitor, ceramic, 82 uuf ±2%, 600V	105940	
R505	Resistor, composition, 47Ω ±10%, 1/2W	108688	
R542	Resistor, variable wirewound, 2K ±10%, 1/4W	113191	
	Matched Resistor Set	*107995	
R504	Resistor, metal film, 1 Meg±1/2%, 1/2W		
R540	Resistor, metal film, 48.75K±1%, 1/2W		
R543	Resistor, metal film, 500K±1/2%, 1/2W		
	AC-Range-Switch Switch Assembly	*125047-4	
S2	Switch, range, AC section	*125120	

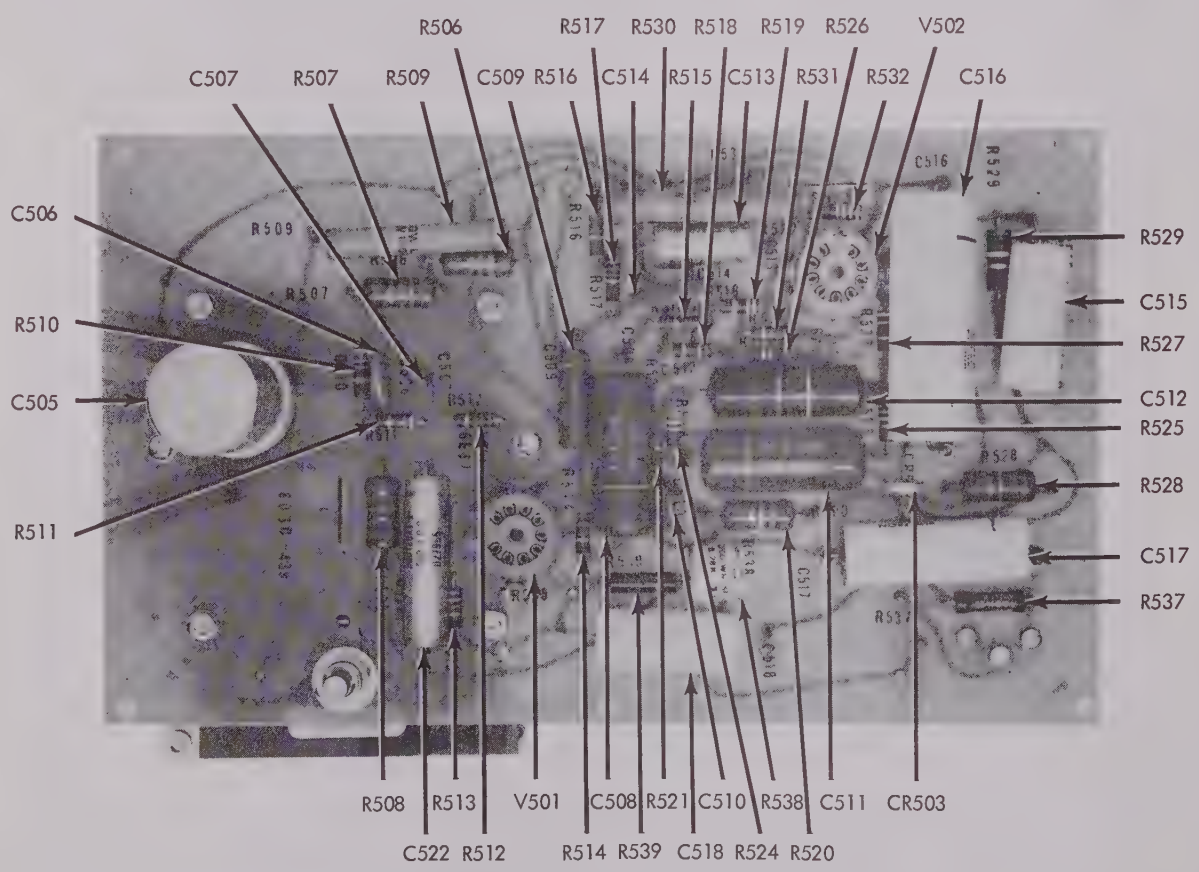


Figure 5-7. CONVERTER/AC RANGE SWITCH ASSEMBLY (Sheet 1 of 2)

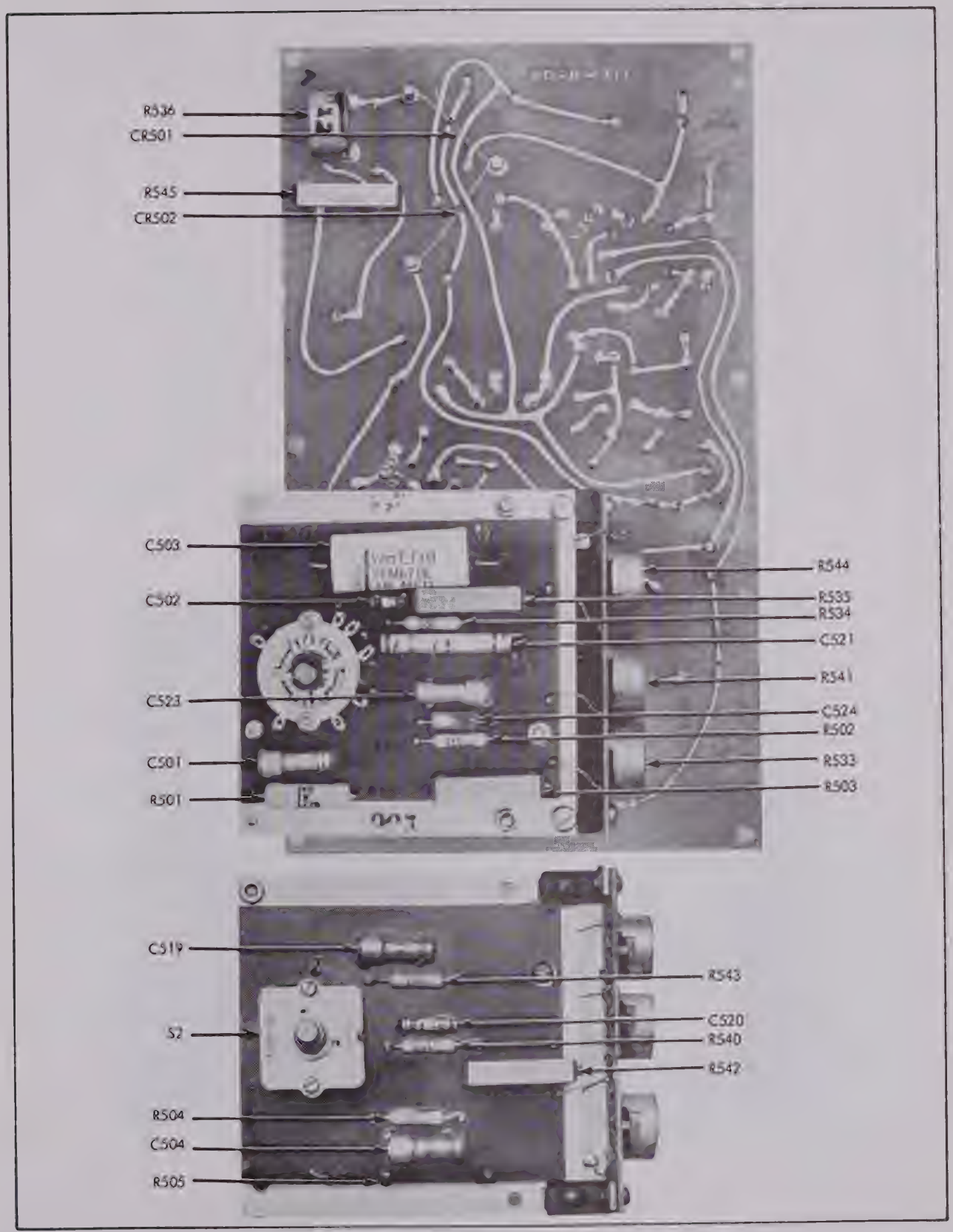


Figure 5-7. CONVERTER/AC RANGE SWITCH ASSEMBLY (Sheet 2 of 2)

REFERENCE DESIGNATION	DESCRIPTION	FLUKE STOCK NO.	USE CODE
	Chopper Drive Assembly	*125211	
C701	Capacitor, plastic, 0.18 uf ±10%, 200V	105874	
C702, C703	Capacitor, electrolytic, 20 uf -10/+100%, 50V	106229	
C704	Capacitor, plastic, 0.18 uf ±10%, 200V	105874	
Q701, Q702	Transistor, germanium, PNP, 2N1379	117143	
Q703, Q704	Transistor, germanium, PNP, 2N1372	116129	
R701	Resistor, deposited carbon, 44.2K ±1%, 1/2W	107912	
R702	Resistor, composition, 120Ω ±10%, 1/2W	108696	
R703	Resistor, deposited carbon, 44.2K ±1%, 1/2W	107912	
R704, R705	Resistor, variable wirewound, 10K ±20%, 1-1/4W	112862	
R706, R707	Resistor, composition, 820Ω ±10%, 1/2W	108423	
R708, R709	Resistor, composition, 120Ω ±10%, 1W	109827	

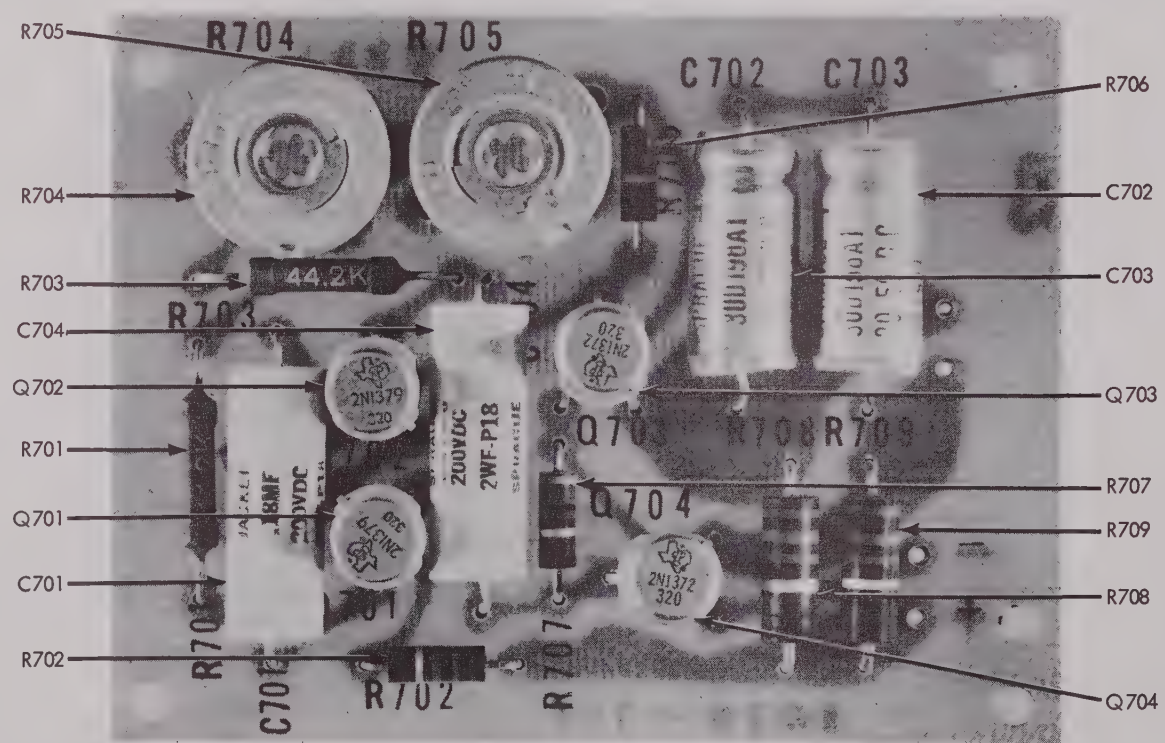


Figure 5-8. CHOPPER DRIVE ASSEMBLY

USE CODE EFFECTIVITY

The following list of use codes is intended to allow the customer to determine the effectivity of all replaceable parts. All parts with no code are used on all instruments with serial numbers above 123. New codes will be added as necessary on forthcoming instruments.

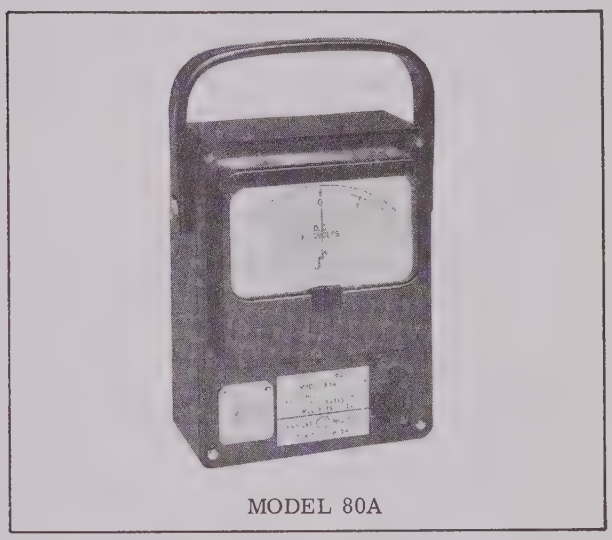
USE CODE	EFFECTIVITY
No Code	Model 823A serial number 123 and on Model 823AR serial number 123 and on
A	Model 823A serial number 123 thru 174 Model 823AR serial number 123 thru 157
B	Model 823A serial number 175 and on Model 823AR serial number 158 and on
C	Model 823A serial number 123 thru 197 Model 823AR serial number 123 thru 157
D	Model 823A serial number 198 and on Model 823AR serial number 158 and on

SECTION VI

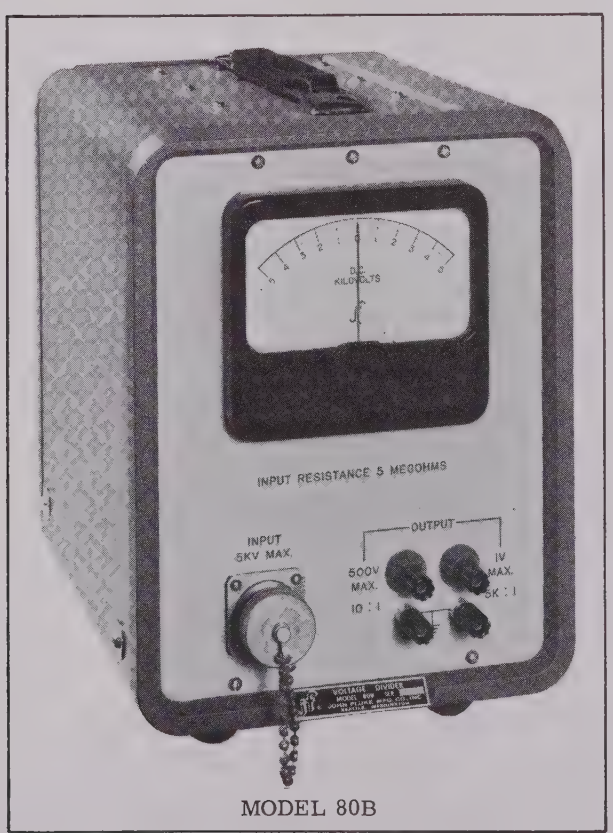
ACCESSORIES

6-1. PRECISION VOLTAGE DIVIDERS

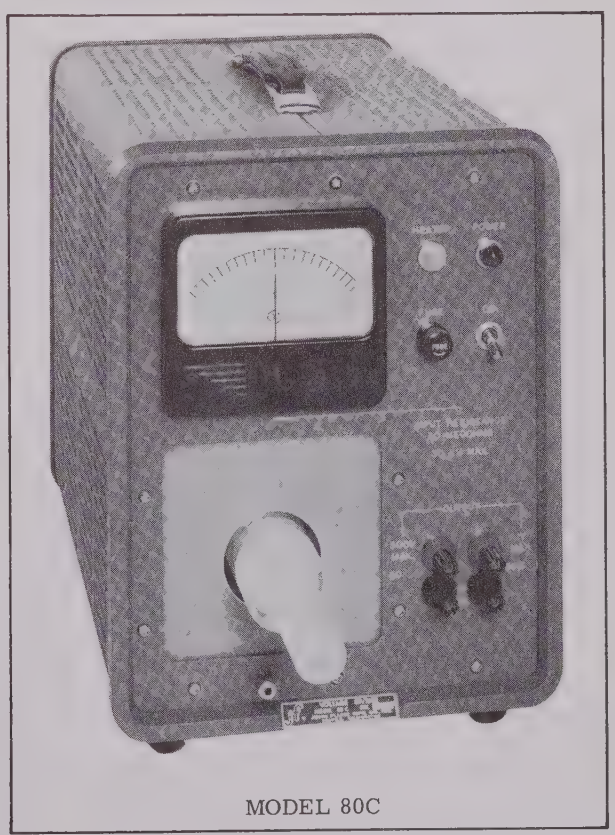
The Fluke 80A, 80B, and 80C Precision Voltage Dividers provide the ff 800 Series Differential Voltmeters with the ability to make high accuracy measurements up to 30,000 volts DC. All models contain a zero center panel meter which allows the polarity and approximate magnitude of the unknown high voltage to be easily observed. At maximum input, all units draw but 1 ma of current from the unknown. The extreme accuracy and excellent long term stability of these dividers are obtained by using properly aged precision wirewound resistors which have a very low temperature coefficient. To further ensure high accuracy and long term stability at very high voltages, the 80C dividers have all resistance components immersed in oil within a hermetically sealed container. As an additional feature, all 80B and 80C models are provided with a 1 volt tap which allows measurements of high voltages with a laboratory potentiometer. Specifications for the standard models are shown on next page. Other intermediate models are available upon special request.



MODEL 80A



MODEL 80B



MODEL 80C

Model No.	Maximum Input Voltage	Total Resistance	Current Drawn At Max. Input	Division Ratio		Division Accuracy	Stability of Division Accuracy Per Year	Temp. Coef. of Division Ratio
				500 V Out	1 V Out			
80A-1 80A-2	1 KV 2 KV	1 M 2 M	1 ma	2:1 4:1	—— ——	±0.015%	——	——
80B-5 80B-10	5 KV 10 KV	5 M 10 M	1 ma	10:1 20:1	5,000:1 10,000:1	±0.01%	±0.005%	±0.005%/°C from 0°C to 60°C
80C-15 80C-20 80C-25 80C-30	15 KV 20 KV 25 KV 30 KV	15 M 20 M 25 M 30 M	1 ma	30:1 40:1 50:1 60:1	15,000:1 20,000:1 25,000:1 30,000:1	±0.01%	±0.0005%	±0.0002%/°C from 0°C to 35°C

MODELS	SIZE	INPUT CONNECTOR	OUTPUT CONNECTOR
80A	6-3/4" high 5-1/4" wide 2-1/4" deep	UG-560U with mating connector supplied	Insulated binding posts on 3/4" centers
80B	10-9/32" high 8" wide 10" deep	AN3102-18-165 with mating connector supplied	Insulated binding posts on 3/4" centers for both outputs
80C	13" high 9-3/4 " wide 16" deep	Special 5" ceramic standoff with mating 8" polystyrene connector supplied	Insulated binding post on 3/4" centers for both outputs

MODEL A-70 POTENTIOMETRIC RECORDER

6-2. POTENTIOMETRIC RECORDER

The Fluke Model A-70 Self Balancing Potentiometric Recorder is a special purpose high sensitivity recorder developed for monitoring voltages measured by the ℱ 800 Series Differential Voltmeters. In addition to providing a permanent record of results, the recorder allows unattended monitoring of various voltages from 0 to 500 volts for long periods of time. A sample voltage which varies in direct proportion to the source under measurement is obtained from the voltmeter null detector by connecting the recorder to the output terminals at the rear of the voltmeter. A gain adjustment control adjacent to the voltmeter output terminals allows the sample voltage to be adjusted such that full-scale meter deflection equals full-scale recorder deflection. The large leakage resistance (500,000 megohms) between the recorder input posts and chassis is such that the inherently high accuracy of the Fluke Differential Voltmeter is generally not impaired in any way.

Electrical Span:	10 mv DC
Span Step Response Time:	Less than 0.5 seconds
Accuracy:	0.5% of span
Chart Speeds:	0.75, 1.5, 3.6, or 12 in./min. or in./hr.

Dimensions:
Cabinet Model--9-1/4" high, 8-1/4" wide, 15" deep.
Rack Model--Available on special request.

WARRANTY

The JOHN FLUKE MFG. CO., INC. warrants each instrument manufactured by them to be free from defects in material and workmanship. Their obligation under this Warranty is limited to servicing or adjusting an instrument returned to the factory for that purpose, and to making good at the factory any part or parts thereof; except tubes, fuses, choppers and batteries, which shall, within one year after making delivery to the original purchaser, be returned by the original purchaser with transportation charges prepaid, and which upon their examination shall disclose to their satisfaction to have been thus defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at a nominal cost. In this case, an estimate will be submitted before work is started, if requested.

If any fault develops, the following steps should be taken.

1. Notify the John Fluke Mfg. Co., Inc., giving full details of the difficulty, and include the Model number, type number, and serial number. On receipt of this information, service data or shipping instructions will be forwarded to you.

2. On receipt of the shipping instructions, forward the instrument prepaid, and repairs will be made at the factory. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the Warranty.

SHIPPING

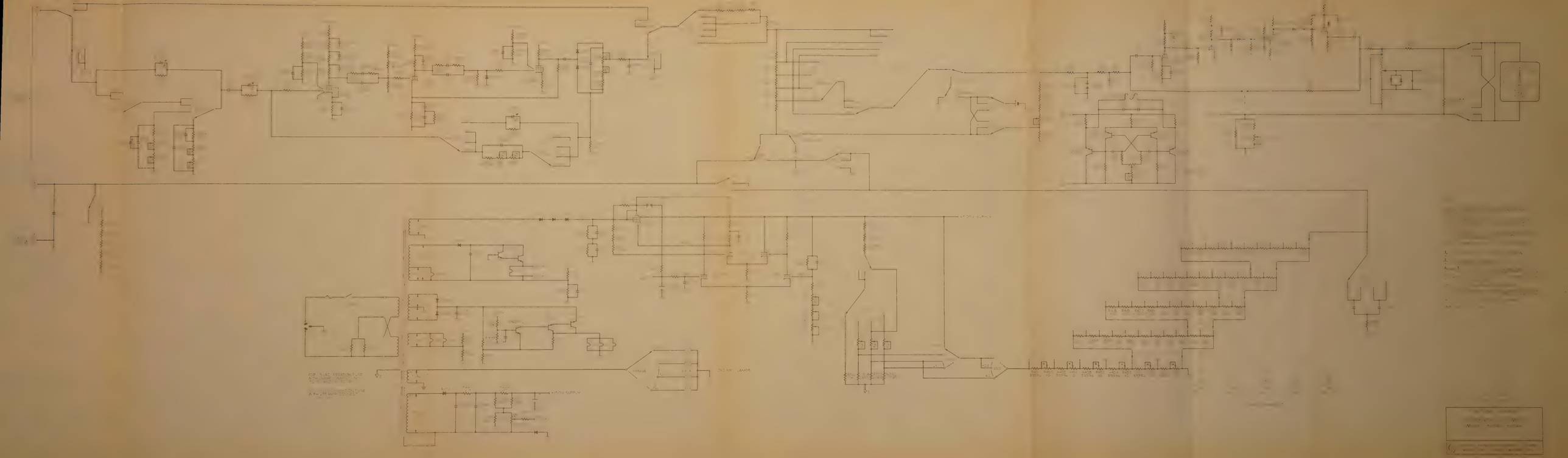
All shipments of John Fluke Mfg. Co., Inc. instruments should be made via Railway Express prepaid. The instrument should be shipped in the original packing carton; or if it is not available, use any suitable container that is rigid. If a substitute container is used, the instrument should be wrapped in paper and surrounded with at least four inches of excelsior or similar shock-absorbing material.

CLAIM FOR DAMAGE IN SHIPMENT

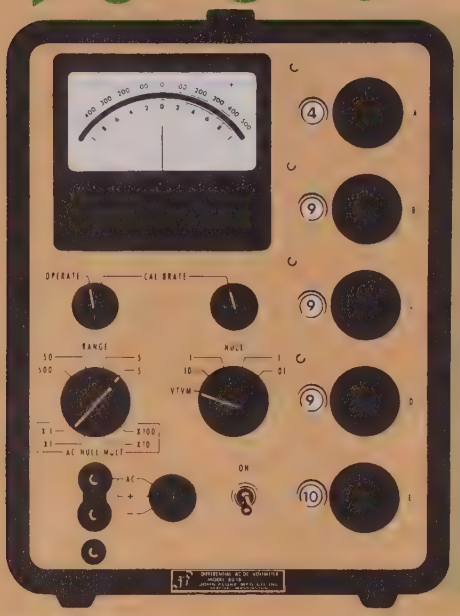
The instrument should be thoroughly inspected immediately upon receipt. All material in the container should be checked against the enclosed packing list. The manufacturer will not be responsible for shortages against the packing sheet unless notified immediately. If the instrument fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to John Fluke Mfg. Co., Inc. Upon receipt of this report you will be advised of the disposition of the equipment for repair or replacement. Include the model number, type number, and serial number when referring to this instrument for any reason.

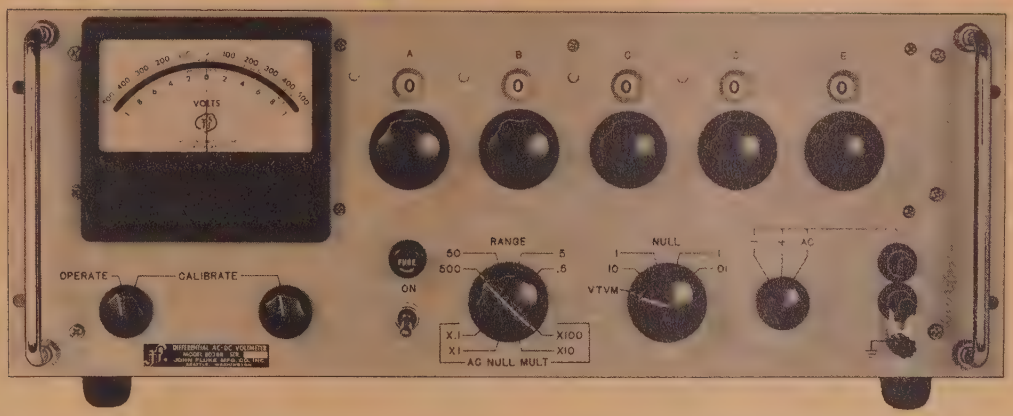
The John Fluke Mfg. Co., Inc. will be happy to answer all application questions which will enhance your use of this instrument. Please address your requests to:

JOHN FLUKE MFG. CO., INC., P. O. BOX 7428, SEATTLE 33, WASHINGTON



1963





JOHN FLUKE MFG. CO., INC.

PRECISION INSTRUMENTS

CATALOG DIGEST 3-63

DIFFERENTIAL VOLTMETERS • MILITARIZED DIFFERENTIAL VOLTMETER • TRUE RMS VOLTMETER

POWER SUPPLIES • CALIBRATORS • THERMAL TRANSFER STANDARDS • THERMAL CONVERTERS

UNIVERSAL IMPEDANCE BRIDGE • VAW METER • PRECISION VOLTAGE DIVIDERS • ACCESSORIES

FLUKE DIFFERENTIAL VOLTMETERS

Accuracy • Reliability • Ruggedness • Versatility

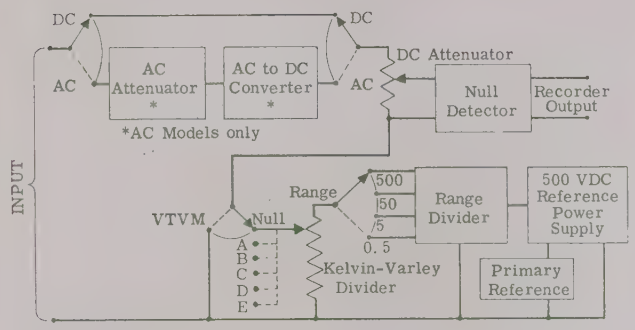
a great combination . . .

provided by each instrument in the Fluke line of differential voltmeters—advantages unequaled in any other type of voltage measuring instrument available in today's market.

In addition, when extreme DC measurement accuracy is required, there is complete freedom from source loading error provided by infinite input impedance, another feature common to all Fluke Differential Voltmeters. The table below illustrates the importance of this feature.

SOURCE LOADING ERROR

Source Resistance	Voltmeter With 10 Megohm Input Resistance	Fluke Voltmeter At Null
1 K	0.01%	0
5 K	0.05%	0
10 K	0.1%	0
50 K	0.5%	0
100 K	1%	0
500 K	4.8%	0
1 M	9.1%	0



Examination of the simplified block diagram reveals that the Fluke DC Differential Voltmeter is composed of four basic sections:

(1) A primary reference, either standard cell or zener diode, used to calibrate . . .

(2) the 500V precision reference supply, which is applied across . . .

(3) the Kelvin-Varley voltage divider, the output of which is adjusted by the voltage dials to equal the unknown being measured. Equality between the Kelvin-Varley output and the unknown voltage is determined by . . .

(4) the null detector, a chopper-stabilized DC amplifier.

The following are a few examples of the many advantages of infinite input impedance:

(1) Critical tube and transistor potentials are unaffected by measurement.

(2) Long leads to the voltage source have no effect on accuracy (such as remote thermocouple measurements).

(3) Measurements in the DC feedback loop of amplifiers and servos have no effect on over-all gain.

(4) Absolute measurements may be made where source resistance is unknown or difficult to determine.

(5) Stored potentials and electrostatic sources may be measured without reducing the source voltage.

(6) Voltage ratios of divider networks remain constant when a measurement is made across a portion of the divider.

AC/DC versions of the Fluke Differential Voltmeters (Models 803B, 803D, and 823A) provide the capability of highly accurate, wide frequency range AC measurements in addition to the DC capabilities described above. This is accomplished by means of an AC to DC converter placed ahead of the DC portion of the instrument. The heart of this converter is an extremely stable, low noise amplifier, with virtually flat frequency response over the specified frequency range.

AC/DC

MODEL 803B

INPUT VOLTAGE RANGE:
0 to 500V AC and DC

ACCURACY (% OF INPUT):
DC: ±0.05% from 0.1 to 500V DC
±(0.05% +50 uv) below 0.1V DC

AC: (20 cps to 10 KC)
±0.2% from 0.5 to 500V AC
±(0.2% +25 uv) from 0.001 to 0.5V AC
(10 cps to 20 cps)
±(0.5% +25 uv) from 0.001 to 500V AC
(5 cps to 10 cps)
±(3% +25 uv) from 0.001 to 500V AC

NULL RANGES:
±10, ±1, ±0.1, ±0.01V AC and DC;
±100, ±0.001V AC

INPUT IMPEDANCE:
DC: Infinite at null from 0 to 500V DC
AC: 1 Megohm, 35 uuf (500 and 50V AC ranges)
1 Megohm, 50 uuf (5 and 0.5V AC ranges)

MAXIMUM METER RESOLUTION:
50 uv DC; 5 uv AC

REFERENCE:
Standard Cell (Zener diode optional)

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 16" deep
Rack Model—19" wide x 7" high x 15½" deep

WEIGHT:
Cabinet Model—27½ pounds
Rack Model—25 pounds

PRICE:
Cabinet Model—$875.00
Rack Model—$895.00

DC

MODEL 801B

INPUT VOLTAGE RANGE:
0 to 500V

ACCURACY (% OF INPUT):
DC: ±0.05% from 0.1 to 500V
±(0.05% +50 uv) below 0.01V

NULL RANGES:
±10, ±1, ±0.1, ±0.01V

INPUT IMPEDANCE:
Infinite at null from 0 to 500V

MAXIMUM METER RESOLUTION:
50 microvolts

REFERENCE:
Standard Cell (Zener diode optional)

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 14" deep
Rack Model—19" wide x 7" high x 14" deep

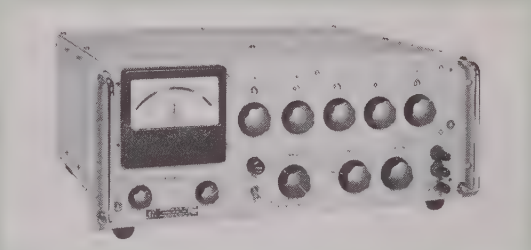
WEIGHT:
Cabinet Model—24 pounds
Rack Model—21½ pounds

PRICE:
Cabinet Model—$485.00
Rack Model—$505.00

FEATURES COMMON TO ALL FLUKE DIFFERENTIAL VOLTMETERS (except Model 8011A)

Infinite input resistance at null from 0 to 500V DC • In-line readout with automatic lighted decimal • Front panel DC polarity switch • No zero controls • Recorder output • • Taut band suspension meter • Flow soldered glass epoxy printed circuit boards • Meets shock and vibration requirements of MIL-T-945A.

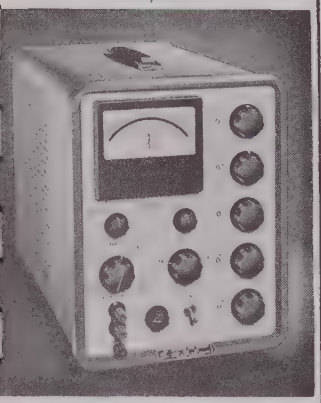
Fluke Model A-70 strip chart recorder is recommended for use with all Fluke differential voltmeters in any application where a permanent record is desired.



MODEL 803BR

All Fluke differential voltmeters are available in either cabinet models, or rack mounting models. Panel dimensions for rack models—7" x 19". Depth behind panel: DC models—14"; AC/DC models 15½".

AC/DC



MODEL 803D

INPUT VOLTAGE RANGE:
0 to 500V AC and DC

ACCURACY (% OF INPUT):
DC: ±0.02% from 0.1 to 500V
± (0.02% +25 uv) below 0.1V
AC: (30 cps to 5 KC)
±0.1% from 0.5V to 500V AC
± (0.1% +25 uv) from 0.001 to 0.5V AC
(20 cps to 10 KC)
±0.15 from 0.5V to 500V AC
± (0.15% +25 uv) from 0.001 to 0.5V AC
Reduced accuracy at extended frequencies from 5 cps to 100KC.

NULL RANGES:
±10, ±1, ±0.1, ±0.01, ±0.001V AC and DC
±100V AC

INPUT IMPEDANCE:
DC: Infinite at null from 0 to 500V DC
AC: 1 megohm, 35 uuf (500 and 50V AC ranges)
1 megohm, 50 uuf (5 and 0.5V AC ranges)

MAXIMUM METER RESOLUTION:
5 microvolts AC and DC

REFERENCE:
Standard Cell (Zener diode optional)

DIMENSIONS:
Cabinet Model—9½" wide x 13" high, x 16" deep
Rack Model—19" wide x 7" high x 15½" deep

WEIGHT:
Cabinet Model—28 pounds
Rack Model—26 pounds

PRICE:
Cabinet Model—$1,100.00
Rack Model—$1,120.00

DC

MODEL 825A

INPUT VOLTAGE RANGE:
0 to 500V

ACCURACY (% OF INPUT):
±0.02% from 0.1 to 500V
± (0.02% +25 uv) below 0.1V

NULL RANGES:
±10, ±1, ±0.1, ±0.01, ±0.001V

INPUT IMPEDANCE:
Infinite at null from 0 to 500V

MAXIMUM METER RESOLUTION:
5 microvolts

REFERENCE:
Standard cell (zener diode optional)

DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 14" deep
Rack Model—19" wide x 7" high x 14" deep

WEIGHT:
Cabinet Model—25 pounds
Rack Model—22 pounds

PRICE:
Cabinet Model—$590.00
Rack Model—$610.00

AC/DC

MODEL 823A

INPUT VOLTAGE RANGE:
0 to 500V AC and DC

ACCURACY (% OF INPUT):
DC: ±0.01% from 0.5 to 500V DC
± (0.01%+10 uv) below 0.5V DC
AC: (30 cps to 5 KC)
±0.1% from 0.5V to 500V AC
+ (0.1%+25 uv) from 0.001V to 0.5V AC
20 cps to 10 KC
±0.15% from 0.5V to 500V AC
± (0.15%+25 uv) from 0.001V to 0.5V AC
Reduced accuracy at extended frequencies from 5 cps to 100 KC.

NULL RANGES:
±10, ±1, ±0.1, ±0.01, ±0.001V AC and DC
±100V AC

INPUT IMPEDANCE:
DC: Infinite at null from 0 to 500V DC
AC: 1 megohm, 35 uuf (500 and 50V AC ranges)
1 megohm, 50 uuf (5 and 0.5V AC ranges)

MAXIMUM METER RESOLUTION:
5 microvolts AC and DC

REFERENCE:
Standard Cell

DIMENSIONS:
Cabinet Model—13" high x 9¾" wide x 16" deep
Rack Model—7" high x 19" wide x 15½" deep

WEIGHT:
Cabinet Model—Approximately 28 pounds
Rack Model—Approximately 26 pounds

PRICE:
Cabinet Model—$1,300.00
Rack Model—$1,320.00

DC

MODEL 821A

INPUT VOLTAGE RANGE:
0 to 500V

ACCURACY (% OF INPUT):
±0.01% from 0.5 to 500V
± (0.01% +10 uv) below 0.5V

NULL RANGES:
±10, ±1, ±0.1, ±0.01, ±0.001V

INPUT IMPEDANCE:
Infinite at null from 0 to 500V

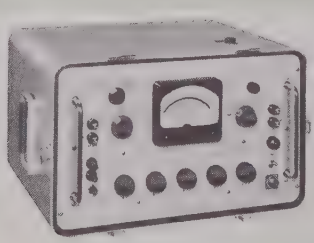
MAXIMUM METER RESOLUTION:
5 microvolts

REFERENCE:
Standard cell

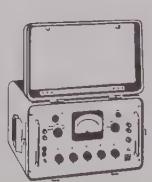
DIMENSIONS:
Cabinet Model—9¾" wide x 13" high x 14" deep
Rack Model—19" wide x 7" high x 14" deep

WEIGHT:
Cabinet Model—25 pounds
Rack Model—22 pounds

PRICE:
Cabinet Model—$795.00
Rack Model—$815.00



MODEL 8011A



DESIGNED FOR:

Continuous operation..... from —54°C to +65°C with 95% relative humidity up to an altitude of 10,000 feet

Extended storage..... from —65°C to 85°C with 100% relative humidity up to an altitude of 50,000 feet

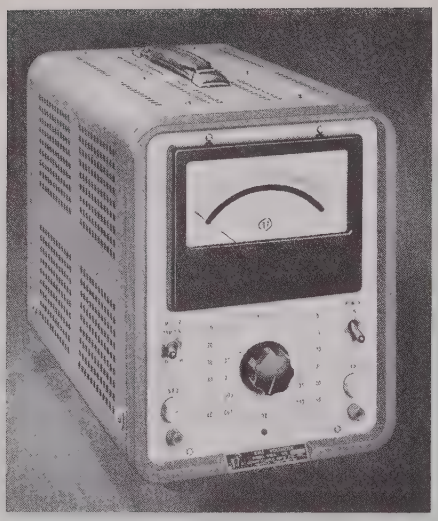
MILITARIZED-DC DIFF. VOLTMETER

Meets all environmental requirements of MIL-T-945A

The Model 8011A is a potentiometer built to provide accurate voltage measurements under adverse environmental conditions. Housed in a light grey enameled combination case, it is portable, and virtually impossible to damage by overload. Chopper stabilized null detector, precision Kelvin-Varley resistors (hermetically sealed in oil), temperature controlled Zener reference, and drift free 500 volt reference supply, all contribute to the outstanding performance of this instrument.

SPECIFICATIONS

INPUT VOLTAGE RANGE: 0 to 500V
ACCURACY: ±0.05% of input from 0.1 to 500V
±0.1% of input or 50 uv, whichever is greater, below 0.1V
NULL RANGES: ±10, ±1, ±0.1, ±0.01V
INPUT IMPEDANCE: Infinite at null from 0 to 500V
MAXIMUM METER RESOLUTION: 50 uv
REFERENCE: Temperature controlled Zener diode
DIMENSIONS: Combination case with cover
19" wide x 11½" high x 19½" long
WEIGHT: 57 pounds **PRICE:** $1745



MODEL 910A

FLUKE

TRUE RMS VOLTMETER

The Model 910A true RMS Voltmeter combines true RMS response with 1.0% accuracy over a broad frequency range. Its true RMS response, by definition, guarantees that the accuracy of the indicated reading is maintained regardless of its waveform characteristics.

SPECIFICATIONS

Voltage Range: 100 uv to 300V in twelve ranges

Decibel Range: —72 to +52 dbm in twelve ranges

Frequency Response: 10 CPS to 7 MC

Accuracy: ±1% of full scale 50 cps to 800 KC
±2% of full scale 20 cps to 2 MC
±3% of full scale 20 cps to 3.5 MC
±5% of full scale 10 cps to 7.0 MC

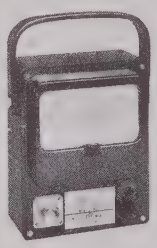
Crest Factor: Three at full scale. Nine at range switchover point.

Input Impedance: 10 megohms shunted by 30 uuf on ranges from 0.001V to 0.30V
10 megohms shunted by 15 uuf on ranges from 1.0 to 300V

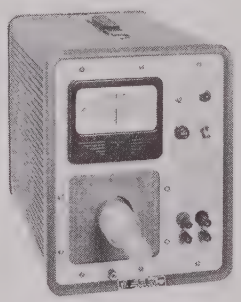
Amplifier: Output terminals provide approximately 100 mv RMS at full scale regardless of range

Dimensions: Cabinet Model—7¼" wide x 10½" high x 15" deep
Rack Model—19" wide x 5¼" high x 13¼" deep

Price: Cabinet Model—$525.00
Rack Model—545.00



MODEL 80A



MODEL 80C

PRECISION VOLTAGE DIVIDERS

Designed for use with the Fluke Model 800 Series Differential Voltmeters, Fluke precision voltage dividers provide high accuracy measurements to 30,000V DC. All units have zero center panel meters to indicate polarity and approximate magnitude of unknown high voltage. All models draw 1 ma current at maximum input.

Model No.	Maximum Input Voltage	Total Resistance	Division Ratio 500 V Out	Division Ratio 1 V Out	Division Ratio Accuracy	Price
80A-1	1 KV	1M	2:1	—	±0.015%	$ 100.00
80A-2	2 KV	2M	4:1	—	±0.015%	110.00
80B-5	5 KV	5M	10:1	5,000:1	±0.01%	225.00
80B-10	10 KV	10M	20:1	10,000:1	±0.01%	350.00
80C-15	15 KV	15M	30:1	15,000:1	±0.01%	720.00
80C-20	20 KV	20M	40:1	20,000:1	±0.01%	845.00
80C-25	25 KV	25M	50:1	25,000:1	±0.01%	970.00
80C-30	30 KV	30M	60:1	30,000:1	±0.01%	1,095.00

MODEL 102

VAW METER

The Fluke Model 102 Vaw Meter measures voltage, current, and power over a wide frequency range. The Model 102 has a maximum true power sensitivity of 225 microwatts and will measure up to 18 kilowatts over the frequency range of 20 cps to 100 kc. With a one megohm input resistance and a shunt drop of only 45 millivolts full scale, the Model 102 generally produces negligible insertion loss effects on the circuit under test. This instrument is designed to measure true power consumed by a wide variety of loads including both linear and non linear elements such as servo components, transformers, rectifiers, and substantially any power-consuming circuit configuration.

BRIEF SPECIFICATIONS

Voltage full scale: 1.5-600V

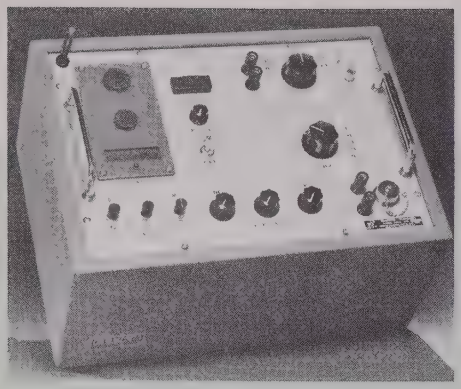
Current full scale: 1.5 ma-30 amps

Power: 225 uw to 18 kw

Cabinet Model: $660.00

Rack Model: $680.00

POWER FACTOR RANGE	FREQUENCY RESPONSE	ACCURACY	INPUT IMPEDANCE
1.0	20 cps-40 KC	3%	1 megohm 25 uufd
1.0	40 KC-100 KC	10%	
0.1	20 cps-20 KC	3%	
0.1	20 KC-40 KC	10%	



FLUKE

THERMAL TRANSFER STANDARDS

Model 540A Thermal Transfer Standard provides extreme accuracy over a frequency range of 5 cps-500 KC. A prime advantage offered by Model 540A is that the AC and DC voltages on any range are always applied to the same portion of the transfer circuitry on a 1:1 basis thereby eliminating any error which might occur if the AC voltage were first divided down to a lower level before comparison to the DC standard voltage.

Certified by N.B.S.

MODEL 540A

FEATURES

0.02% AC/DC Transfer Accuracy • Frequency Range 5 cps—500 KC • Voltage Range 0.33 to 1000V • Search Meter for Visual Indication of Overload • High-resolution Galvanometer • Excellent Thermal Drift Characteristics • Built-in Provisions for use with:

Model A55 High Frequency Thermal Converters

Model A40 Current Shunts for AC Current Measurements

External Galvanometer

SPECIFICATIONS

VOLTAGE RANGES: 0.5, 1, 2, 3, 5, 10, 20, 30, 50, 100, 200, 300, 500, 1000 volts.

ACCURACY:

RANGES	FREQUENCY	AC/DC DIFFERENCE
0.5V	5 cps - 100 KC	±0.02%
	100 KC - 500 KC	±0.05%
1V-10V	5 cps - 500 KC	±0.02%
20V-50V	5 cps - 100 KC	±0.02%
	100 KC - 500 KC	±0.2%
100V-300V	5 cps - 50 KC	±0.03%
500V	5 cps - 50 KC	±0.05%
1000V	5 cps - 20 KC	±0.05%

CALIBRATION: Traceable to NBS standards over entire range.

Available at extra cost—
NBS Certificate to 50 KC (20 KC on 1000V range) with correction figures given to ±0.01%.
Fluke or NBS certified test report over entire range.

TRANSFER INPUT IMPEDANCE: 200 ohms per volt.

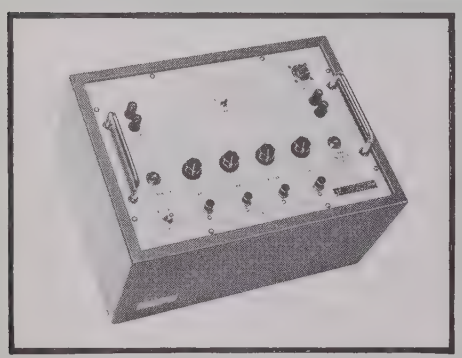
GALVANOMETER: Built-in reflecting type Binding posts and switch provided for external galvanometer.

GALVANOMETER RESOLUTION: 0.02% per millimeter at nominal range voltage.

SEARCH METER: This circuit is provided to select the proper voltage range thereby minimizing the possibility of thermocouple overload.

DIMENSIONS: 10¾" wide x 8½" high x 14½" long.

WEIGHT: 11½ pounds. **PRICE:** $795.00



Model 550A incorporates a four-dial Lindeck potentiometer, DC reference supply, polarity reversing switch, terminals for external galvanometer, and is specifically designed to complement the extreme accuracy of Model A55 converters. Included with each Model 550A is a shielded galvanometer cable and a Model 550A/A55 interconnection cable.

MODEL 550A

SPECIFICATIONS

REFERENCE VOLTAGE RANGE: 1.1 to 15 millivolts. (NOTE: Output voltage range of Fluke Model A55 Thermal Converters is approximately 1.8 to 7 millivolts from ½ to 1 times rated voltage.)

GALVANOMETER RESOLUTION: Between 0.001% and 0.006% mm on high sensitivity transfer range when used with Model A55 Thermal Converters and commercially available high-resolution galvanometers of the lightbeam reflecting type.

DC OUTPUT CONNECTOR: GR Type 874.

GALVANOMETER AND THERMAL CONVERTER INPUT CONNECTOR: Amphenol 80-PC2M two-pin microphone type.

SIZE: 15" long x 10¾" wide x 9⅜" high (including cover).

WEIGHT: 14½ pounds (including cable and cover).

PRICE: $295.00.

THERMAL CONVERTERS

Model A55 Thermal Converters make possible extremely accurate thermal transfer AC measurements from sub-audio frequencies to the VHF range. Great care has been taken in the electrical design and packaging to ensure continued accuracy comparable to NBS standards even under adverse conditions of temperature, humidity, and vibration.

SPECIFICATIONS

RANGE: 0.5, 1, 2, 3, 5, 10, 20, 30, and 50 volts. (NOTE: Each converter may be used from ½ to 1 times voltage rating.)

CONVERTER	AC/DC DIFFERENCE 1 MC	10 MC	30 MC	50 MC
0.5V	±0.01%	+0.10%	+0.50%	+1.50%
1V-10V	±0.01%	±0.03%	±0.10%	±0.10%
20V-50V	±0.01%	±0.05%	±0.10%	—

CALIBRATION: Certified to be within the above deviations from zero error as defined by NBS without calibration curves or correction tables. The 0.5V model is supplied with a test report indicating deviations to the nearest 0.01% at the above frequencies. For any converter, John Fluke or NBS certified test reports are available at extra cost.

INPUT IMPEDANCE: Approximately 200 ohms/volt.

OUTPUT VOLTAGE: 7 millivolts nominal at rated input.

OUTPUT RESISTANCE: 8 ohms nominal.

INPUT CONNECTOR: GR type 874-L.

OUTPUT CONNECTOR: Amphenol 80-PC2M 2-pin microphone type.

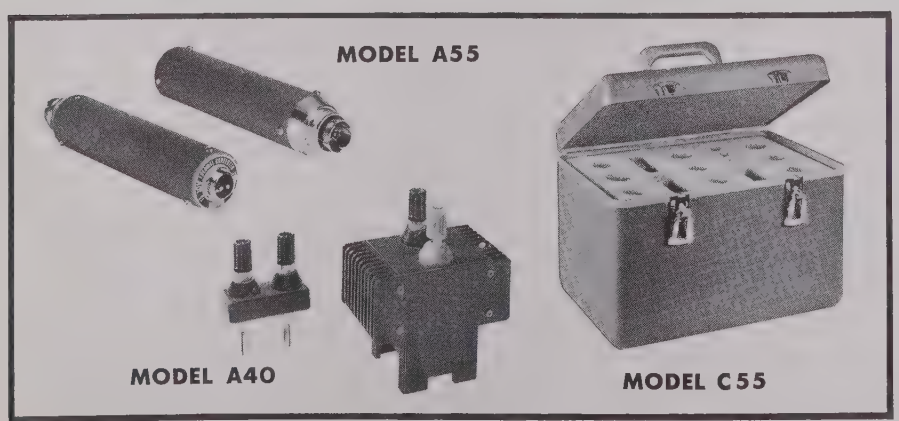
SIZE AND WEIGHT

CONVERTER	DIAMETER	LENGTH	WEIGHT
0.5V	1-3/8"	3-5/16"	10 oz.
1V, 2V	1-3/8"	5-3/16"	13 oz.
3V, 5V	1-3/8"	6-1/2"	15 oz.
10V, 20V 30V, 50V	1-3/8"	7-1/16"	1 lb.

PRICE:

0.5V $100.00
1V, 2V, 3V, or 5V. $125.00
10V, 20V, 30V, or 50V. $150.00

Model C55 storage case, $95.00 (furnished at no charge with orders for complete set of nine converters).



Model A55-110 Accessory Kit is recommended for use with Model A55 thermal converters in virtually any typical calibration or measurement setup.

Model A55-110 Accessory Kit includes:

Coaxial Tee for A55 Thermal Converter Input (GR Type 874-TL).

Three Coaxial Adapters for A55 Thermal Converter Input (GR874 to UHF jack, GR874 to BNC jack, GR874 to Type N jack).

Interconnecting Coaxial Cable, AC Source to Coaxial Tee. **KIT PRICE: $75.00.**

Model A40 AC current shunts in 13 ranges covering 10 ma-10 A for use with Model 540A Thermal Transfer Standard to cover the frequency range from 5 cps to 20 KC with accuracies comparable to Model 540A Transfer Standard. Contact your nearest Fluke representative for complete data.

FLUKE DC POWER SUPPLIES

The DC power supply is the most commonly used instrument for a great variety of applications ranging from research and development through production line testing and is often an essential system component. It is particularly important that each power supply considered should provide the utmost in flexibility of use and reliable performance at minimum cost.

Fluke DC power supplies incorporate unique design features which assure accuracy, resolution, stability, and regulation against line or load changes. No premium in cost is added by these features which are passed along as added user benefits.

PRECISION CALIBRATORS

Suggested Applications: Circuit development, reference source for production checkout system, direct meter calibration, calibration of telemetry system, analog computer system reference DC source for AC/DC transfer measurement, precision source for research work, general purpose laboratory applications.

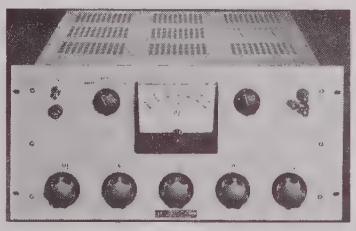
MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY			CALIBRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD	PER HOUR	PER DAY	PER MO.				
313A	0-50 v	0-2A	0.0005%	0.0005%	0.002%	0.0025%	0.005%	0.01%	100 uv	10 uv	$1,295.00
301E	1.02-512 v	0-300 ma	0.005%	0.01%	0.005%	0.01%	0.01%	0.1%	2 mv	500 uv	695.00
301C	1.02-1012 v	0-400 ma	0.005%	0.01%	0.005%	0.01%	0.01%	0.1%	2 mv	500 uv	985.00
334B	0-3111 v	0-400 ma	0.002%	0.005%	0.005%	0.01%	0.01%	0.03%	1 mv	50 uv	2,650.00

NEW MODEL 313A

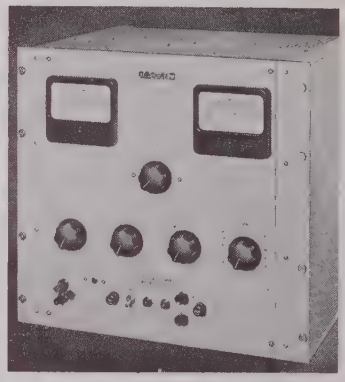
ALL SOLID STATE

313A FEATURES —

Stability 0.005% per month
Calibration Accuracy 0.01%
Line or Load Regulation 0.0005%
Ripple Less Than 100 uv
Maximum Resolution 10 uv
Remote Programming and Load Sensing
Continuously Variable Current Limiting



MODEL 301E



MODEL 301C

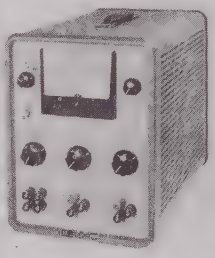
301C AND 301E FEATURES

0.1% Calibration Accuracy
Chopper Stabilization
High Current Output
0.005% Line Regulation
Standard Cell Reference
500 uv Resolution

MODEL 334B

334B FEATURES

0.03% Calibration Accuracy
50 uv Resolution over Entire
0-3111 V Range.
Chopper Stabilization



GENERAL PURPOSE LABORATORY POWER SUPPLY

MODEL 407D

407D FEATURES

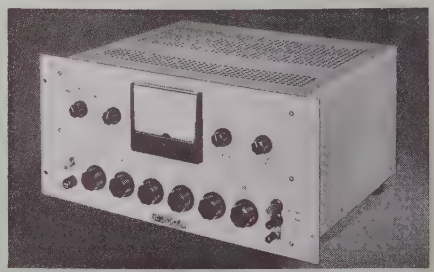
0.01% short term stability—2 mv resolution — Precision fixed and variable wirewound resistors—Dual bias and filament outputs—Tight line and load regulation—Low ripple.

**Model 407D also available as rack mounted model 407DR
19" wide x 8¾" high x 16¾" deep
Weight—48 lbs. Price—$355.00

MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY		CALIBRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD	PER HOUR	PER DAY				
**407D	0-555 v	0-300 ma	0.005%	0.01%	0.01%	0.05%	0.5%	500 uv	2 mv	335.00

CONSTANT CURRENT POWER SUPPLY

Featuring 0.1 microamp resolution coupled with high calibration accuracy and excellent long term stability, Model 351A is particularly useful for calibration and testing of instruments, microammeters and milliammeters, etc.



MODEL 351A

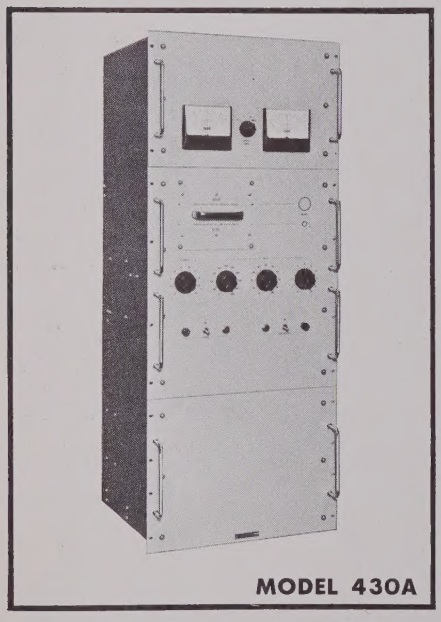
MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY		CALIBRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
			LINE	LOAD	PER HOUR	PER DAY				
351A	0-100 v	1 ua-100 ma	0.01%	0.01%	0.005%	0.01%	0.05%	0.05%	0.1 ua	$845.00

Prices and data subject to change without notice. Prices f.o.b. factory.

HIGH VOLTAGE POWER SUPPLIES

Fluke precision High Voltage supplies offer complete coverage up to 30 kv. Inherent characteristics of high calibration accuracy, tight line-load regulation, fine voltage resolution, excellent long term stability, low temperature coefficient plus freedom from corona, jitter, bounce or overshoot have all contributed to a high degree of customer acceptance and satisfaction.

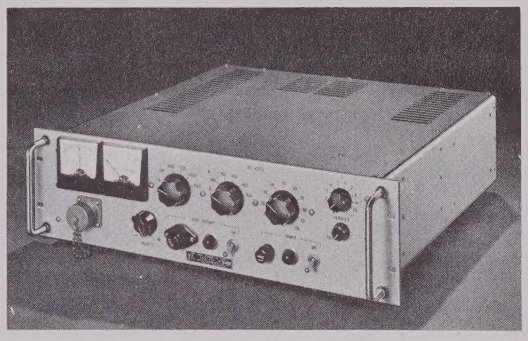
	MODEL	VOLTAGE	CURRENT	REGULATION		STABILITY		CALI-BRATION ACCURACY	MAX. RIPPLE RMS	RESOLUTION	PRICE
				LINE	LOAD	PER HOUR	PER DAY				
TYPICAL APPLICATIONS: Power photo-multiplier tubes and ionization chambers . . . for research and development . . . component evaluation and test . . . system calibration.	409A	170-1530 v	0-3 ma	0.01%	1.2%	0.005%	0.02%	—	0.002%	85 v steps	$ 390.00
	412A	500-2010 v	0-15 ma	0.01%	0.03%	0.005%	0.05%	0.25%	5 mv	10 mv	455.00
	413C	0-3111 v	0-20 ma	0.001%	0.001%	0.005%	0.03%	0.25%	150 uv	2 mv	695.00
	405	600-3100 v	0-15 ma	0.01%	0.015%	0.005%	0.05%	0.5%	5 mv	10 mv	595.00
	408A	500-6010 v	0-20 ma	0.01%	0.01%	0.005%	0.05%	0.25%	5 mv	10 mv	695.00
	410A	1000-10,010 v	0-10 ma	0.01%	0.01%	0.005%	0.05%	0.25%	5 mv	10 mv	1,095.00
	430A	10,000-30,220 v	0-10 ma	0.005%	0.01%	0.005%	0.03%	0.25%	5 mv	100 mv	3,900.00



MODEL 430A

Designed specifically to satisfy the most exacting requirements. Important electrical specifications of this supply are generally 10 : 1 better than any 0-3kv supply available in today's market.

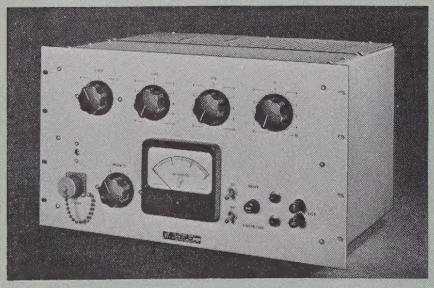
MODEL 413C



For the first time Model 430A extends the precise electrical specifications of the lower voltage Fluke power supplies to the 30 kv region for such specific applications as powering precision high resolution X-ray equipment, cathode ray tube acceleration and focusing in mass spectrometry applications.

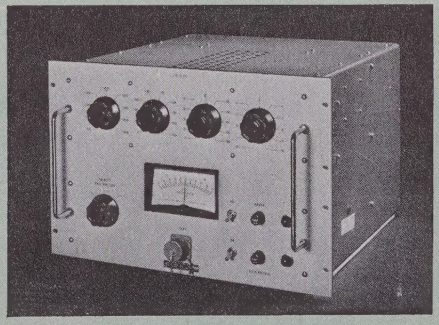
MODEL 409A

MODEL 412A



MODEL 405

MODEL 408A



MODEL 410A

Before you specify, call the Fluke sales engineer nearest you for complete information, or a demonstration of any of the above power supplies. You will find a listing of Fluke sales offices on the back cover of this catalog.

UNIVERSAL IMPEDANCE BRIDGE

MODEL 710B

FEATURES

- Measures R, C, L, D, and Q
- Direct In-Line Readout
- Rugged Shaped-Pole Galvanometer (DC Detector)
- Sensitive Electron-Ray Indicator (AC Detector)
- Designed for Simple, Rapid Operation
- Quick-Change Frequency Networks
- Available for Rack Mounting

Model 710B is designed to allow simple and rapid selection of any one of five different bridge configurations for measurement of AC and DC resistance, capacitance, inductance, dissipation factor (D), and storage factor (Q). Bridge arm resistors and capacitance standard are Fluke-manufactured for high accuracy and low temperature coefficient.

SPECIFICATIONS

RESISTANCE:
0.1 milliohm to 12 megohms in 8 ranges

ACCURACY:
± (0.1%+1 dial division)

CAPACITANCE:
0.1 picofarad to 1200 microfarads in 7 ranges

ACCURACY:
± (0.2%+1 dial division)

INDUCTANCE:
0.1 microhenry to 1200 henrys in 7 ranges

ACCURACY:
± (0.3%+1 dial division)

DISSIPATION FACTOR (D):
0.001 to 1.000 at 1 kilocycle

ACCURACY:
$\pm (2\% + 0.005 \times f_{kc})$

STORAGE FACTOR (Q):
0.1 to 1000 at 1 kilocycle

ACCURACY:
$\pm (2\% + 0.005 \times f_{kc})$

FREQUENCY RANGE:
DC to 20 KC (1 KC Quick-Change networks supplied as standard equipment)

INPUT POWER:
115/230V AC ±10%, 50-800 cps, 12 watts

DIMENSIONS:
Cabinet Model—13″ long x 9½″ wide x 6″ high
Rack Model—7″ high x 19″ wide x 4″ behind panel

WEIGHT:
Cabinet Model—11¾ pounds
Rack Model—10 pounds

PRICE:
Cabinet Model—$485.00
Rack Model—$505.00

OPTIONAL ACCESSORIES:
Quick-Change RC generator and detector networks for the following frequencies; 100 cps, 120 cps, 400 cps, 500 cps, 800 cps, 2 KC, 5 KC, 10 KC, and 20 KC. Price $20.00 per set.

John Fluke Mfg. Co., Inc.

P.O. Box 7428, Seattle 33, Wash.

PR 6-1171 TWX—206-879-1864 TLX—852

FLUKE SALES REPRESENTATIVES IN THE UNITED STATES AND CANADA

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Albany, New York
436-9649

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Barnhill Associates
319A Wyoming Blvd., N.E.
Albuquerque, New Mexico
265-7766

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Wilmington, Massachusetts
REading 944-3930

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South Pasadena, California
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Milwaukee, Wisconsin
EDgewood 2-0700

Minneapolis, Minnesota
Cozzens & Cudahy, Inc.
9725 Girard Ave. So.
Minneapolis, Minnesota
881-2121

New Hartford, New York
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New Hartford, New York
732-3775

New York, New York
G. Curtis Engel & Associates, Inc
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REctor 2-0001

Orlando, Florida
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WAlnut 2-3270

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Oakmont, Pennsylvania
FRemont 1-1231

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BRoadway 4-1100

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McCarthy Associates, Inc.
1011 E. Industrial Way
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Mountlake Terrace, Wash.
PRospect 6-1171

St. Louis, Missouri
Impala, Inc.
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JA 2-1600

Toronto, Ontario, Canada
Allan Crawford Associates, Ltd.
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Wheaton, Maryland
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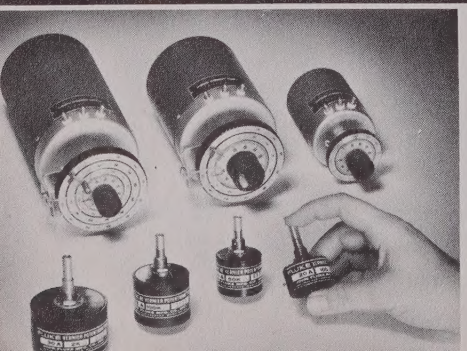
PRECISION VERNIER AND DECADE POTENTIOMETERS AND RHEOSTATS



Fluke quality and reliability are now available in a complete line of precision wirewound vernier and decade potentiometers and rheostats... Fluke linear 20 and 30 series vernier potentiometers range from 100 ohms to 100,000 ohms... Prices: From $8.50 to $30.00

Fluke decade potentiometers and rheostats contain one or more decades, with potentiometer linearity from ±0.1% to ±0.005%, and rheostat accuracies to ±(0.03% +7 milliohms). Prices: From $45.00 to $155.00

FOR FURTHER INFORMATION REQUEST COMPONENTS SHORTFORM CATALOG

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